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# *ham radio*

*magazine*

JULY 1971

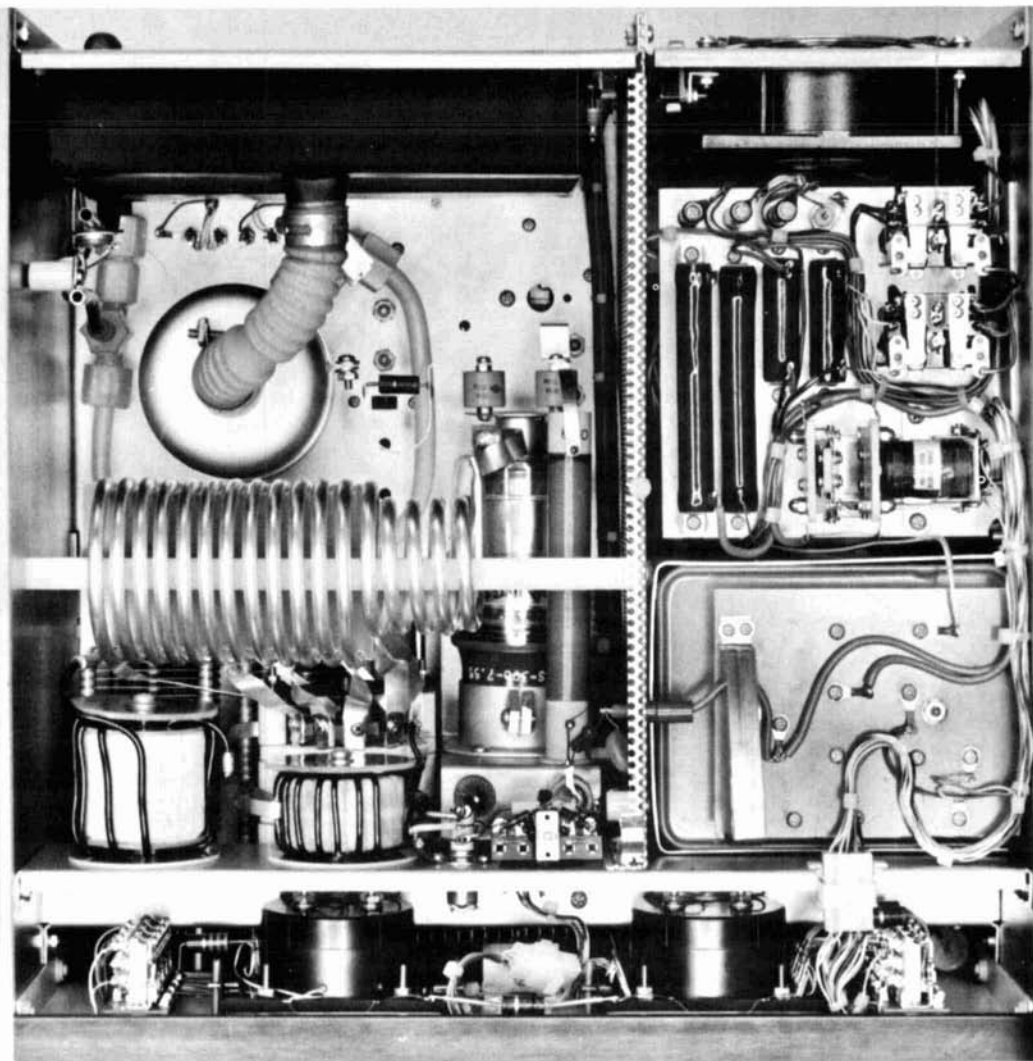


**INTEGRATED-CIRCUIT  
COMMUNICATIONS RECEIVER  
FOR 80 METERS**

## *this month*

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- slow-scan television converter 32
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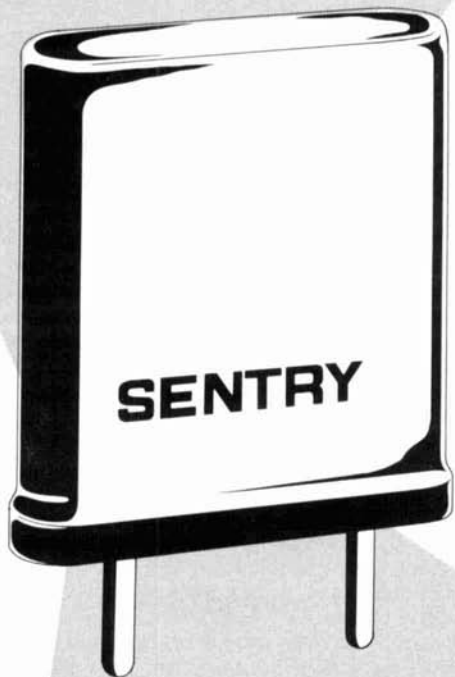


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July, 1971  
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James A. Harvey, WA6IAK  
associate editors

Jean Frey  
art director

Wayne T. Pierce, K3SUK  
cover

T. H. Tenney, Jr. W1NLB  
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Hilda M. Wetherbee  
advertising manager

**offices**

Greenville, New Hampshire 03048  
Telephone: 603-878-1441

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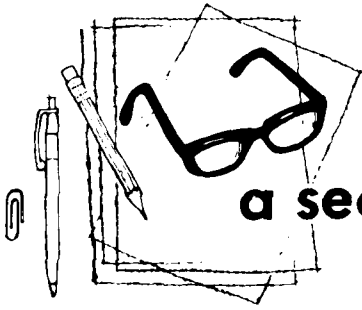
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## a second look

by jim  
fisk

Radio signals from a spacecraft on the other side of the sun have been used to prove, once again, the correctness of Einstein's General Theory of Relativity. This theory, which is an extension of the well known equations that relate mass and energy, is a geometrical theory of gravity, and is of tremendous importance to understanding the universe.

According to the General Theory of Relativity, electromagnetic waves near massive bodies, such as the sun, travel more slowly than they do in free space. Until recently, there have been three methods of testing this theory, all proposed by Einstein. One test involves the slowly-rotating elliptical orbit of Mercury, the planet nearest the sun. Einstein's equations predict the slight rotation of the orbit much more closely than the older gravitational theory of Sir Isaac Newton.

A second test predicts a slight change in the color of the light from the sun and the stars. The stars' intense gravitational fields cause the light they produce to shift toward the red end of the spectrum, as seen from the earth. Although this effect has been observed, it has not been measured accurately because the shift is very slight and difficult to measure.

A third test considers the apparent bending of starlight as it passes through the gravitational field of the sun. However, this can only be measured during a total eclipse of the sun so distant stars can be observed optically. When this rare alignment of the stars took place in 1919 Einstein's predictions were verified with-

in the accuracy of the measuring equipment.

A chance for a fourth test of the General Theory of Relativity occurred recently when the Mariner 6 spacecraft passed near the sun. This is the same craft which flew by Mars in 1969 and measured surface temperatures and atmospheric composition, and sent back television pictures of the planet's surface. Since Mariner 6 passed very close to the sun's intense gravitational field, according to Einstein's equations the radio signals from the spacecraft would be slowed slightly.

To measure this signal delay radio signals were transmitted from earth to a repeater on board the Mariner 6 which returned the signals to earth. The normal round-trip time for the signals, not counting any gravitational affects, is estimated at 45 minutes. According to the General Theory of Relativity the radio signals would be slowed by 200 microseconds as they traveled through the sun's gravitational field.

Information recently released by the Jet Propulsion Laboratory in Pasadena, California indicates that the Mariner 6 radio signals exhibited a maximum relativistic signal delay of about 204 microseconds, within two per cent of that predicted by Einstein's Theory. If the sixteenth-century theory of Isaac Newton were correct there would have been no time delay at all.

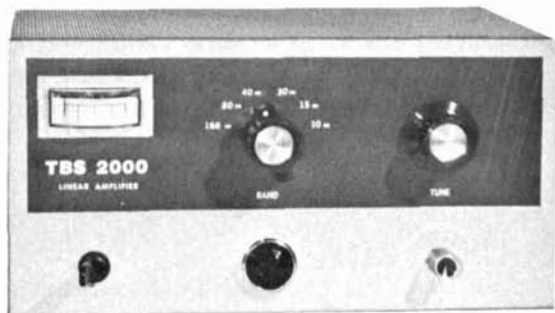
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*It's Truly the State-of-the-Art in Design.*

## SPECIFICATIONS:

**BAND COVERAGE:** 160, 80, 40, 20, 15, and 10 meters  
**INPUT POWER:** 1600 PEP on SSB, 1000 watts on CW  
**DRIVING POWER:** 80-150 watts  
**OUTPUT IMPEDANCE:** 50 ohms nominally  
**TUBE COMPLEMENT:** six RCA 31LQ6  
**PLATE CURRENT METER:** 0-2 amperes, 5% move.  
**RELATIVE OUTPUT INDICATOR:** indicator light  
**RELAY:** built-in antenna change over relay  
**POWER SUPPLY REGULATION:** 3% key-up to key down  
**POWER SUPPLY FILTER CAPACITY:** total of 550 mfd  
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**POLARITY:** cord may be plugged into wall *without regard* to polarity  
**COLOR:** light gray cabinet with dark gray panel inset  
**DIMENSIONS:** cabinet is 11.25" wide, 5.75" high, 8.75" deep  
**WEIGHT:** net 10 lbs (4.6Kg); shipping weight 13 lbs (6 Kg)  
**PRICE:** TBS-2000 \$199.00; TBS-110 \$39.00; TBS-12 TBA

**TOP BAND SYSTEMS, Dept. 3, 5349 Abbeyfield St., Long Beach, CA 90815**



## integrated-circuit communications receiver for 80 meters

A high-performance  
integrated-circuit  
ssb receiver featuring  
half-microvolt  
sensitivity,  
crystal-filter selectivity  
100-dB agc range  
and low-drift vfo

Paul Hrivnak, VE3ELP, 16 Chatterton Boulevard, Scarborough, Ontario, Canada

**Integrated circuits** are being used more and more in the design and construction of amateur radio equipment. The idea for this receiver was originally conceived after reading K7WQR's excellent article on the Motorola MC1596G balanced modulator.<sup>1</sup> In the receiver described here the MC1596G is used as a double-balanced mixer.

The first receiver I built around the MC1596G is shown in block form in **fig. 1**. This original prototype had no front end, i-f amplifier or agc circuits. However, with the high conversion gain provided by the MC1596G\* signals on 80 meters were copied with little effort.

The second design, shown in **fig. 2**, added an RCA 40673 zener-protected dual-gate mosfet rf amplifier stage ahead of the MC1596G mixer. However, manual control of rf and audio gain was still required to listen comfortably to signals on 80 meters. (The front panel has an rf gain control which is not used in the final design; this was used in the second prototype.)

An agc system for a receiver with no i-f stages presented a real problem. I was stuck until I discovered the Plessey SL-600 series of integrated circuits. One of these ICs, the SL621, is designed specifically for gain control circuitry; another, the SL610, is designed for rf amplifier applications. With the discovery

\*Gain of the MC1596G is typically 24 dB when impedances are properly matched.



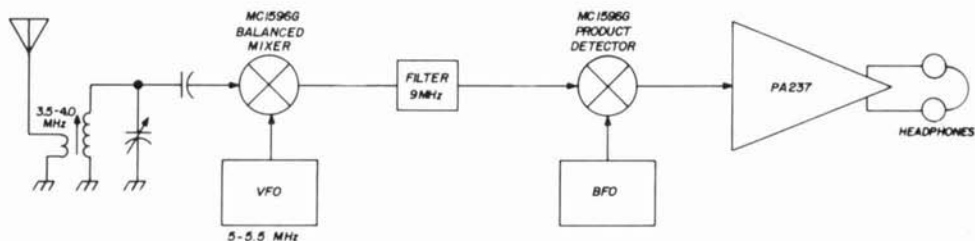


fig. 1. Block diagram of the original receiver design. No front-end, i-f strip or agc was required for copying signals on 80 meters.

of these vital links, the receiver design finalized into the form shown in fig. 3.

As can be seen from the schematic and photographs, modular construction was used throughout the receiver. This speeds construction time, allows bench testing of all modules before deciding on final mechanical design, and allows for circuit changes without upsetting the physical layout.

## rf amplifier

The Plessey SL610C is a low-noise, low-distortion rf voltage amplifier with integral supply-line decoupling and provisions for agc. It has a 50-dB agc range with maximum signal handling capability of 250 mV rms.

The rf amplifier stage was built on single-sided copper-clad printed-circuit board. Generous quantities of Teflon

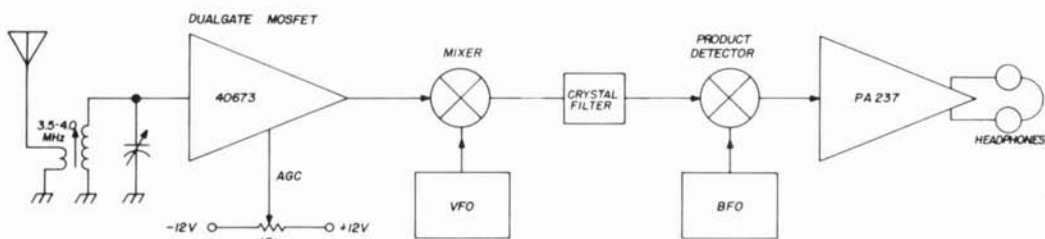
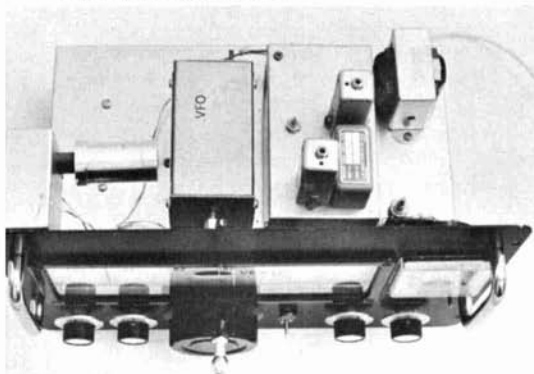


fig. 2. Second receiver design added a dual-gate mosfet rf amplifier stage.

Top view of the receiver with 100-kHz crystal oscillator on the left, 5-MHz vfo in center, and high-frequency mixer, crystal filter and power transformer to the right.

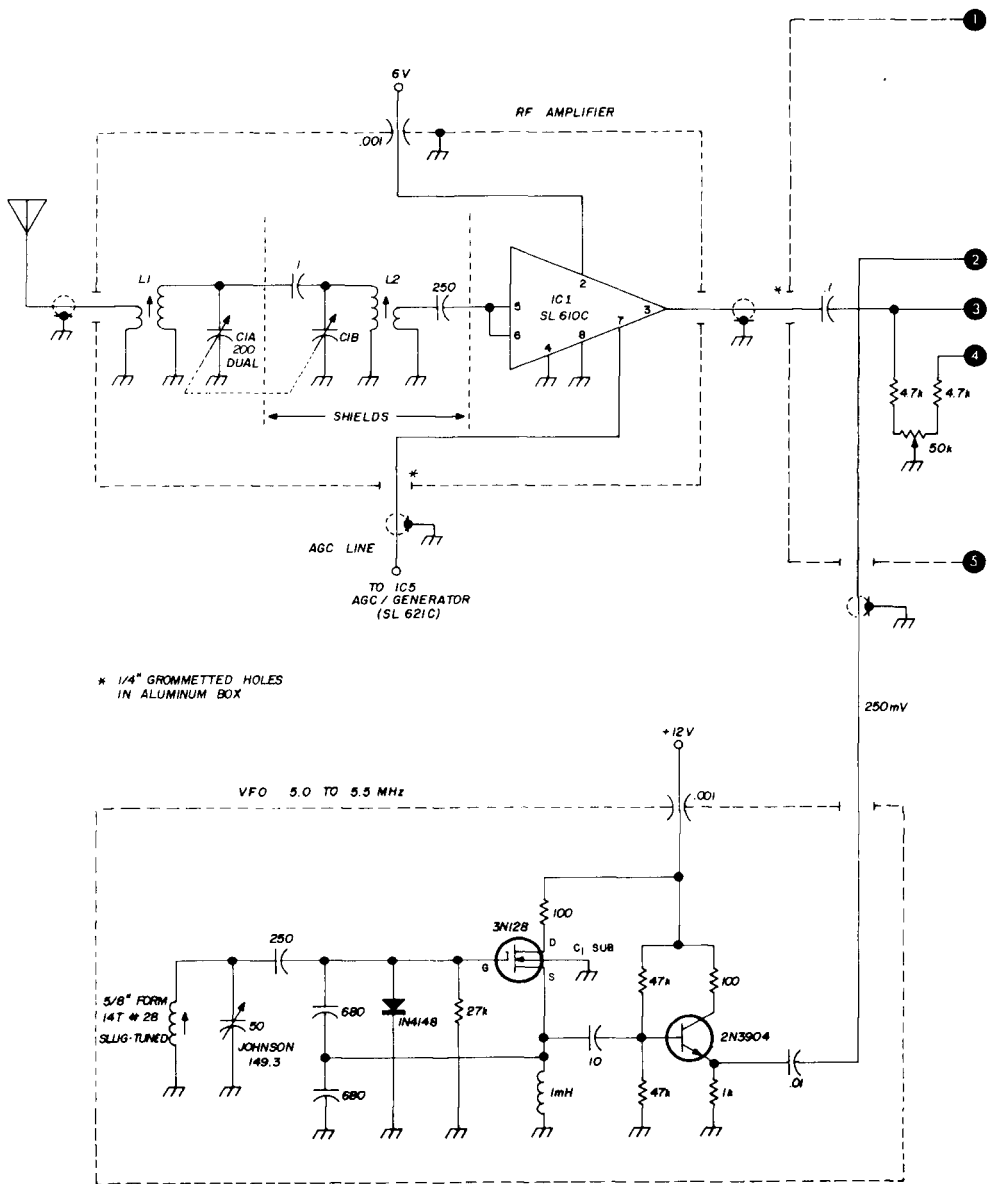


push-through terminals keep construction simple and leads short and direct. Miniature RG-174/U coaxial cable is used in the rf amplifier and to connect the modules together throughout the receiver. Expensive coaxial connectors are eliminated by running the coax through rubber grommets in the chassis.

The rf amplifier, as well as the other individual circuit modules, is housed in a small minibox; power-supply voltage is fed in through a 0.001- $\mu$ F feedthrough capacitor. With this construction technique no oscillations were experienced; gain is approximately 18 dB.

## mixer and filter

Except for the addition of ssb input



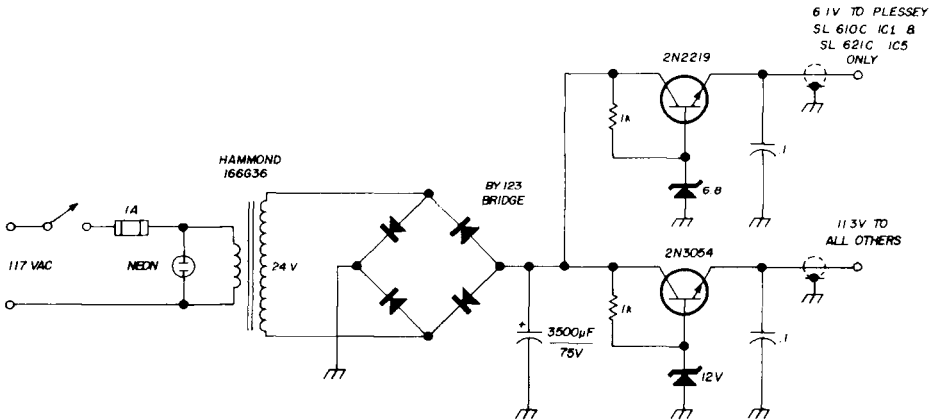
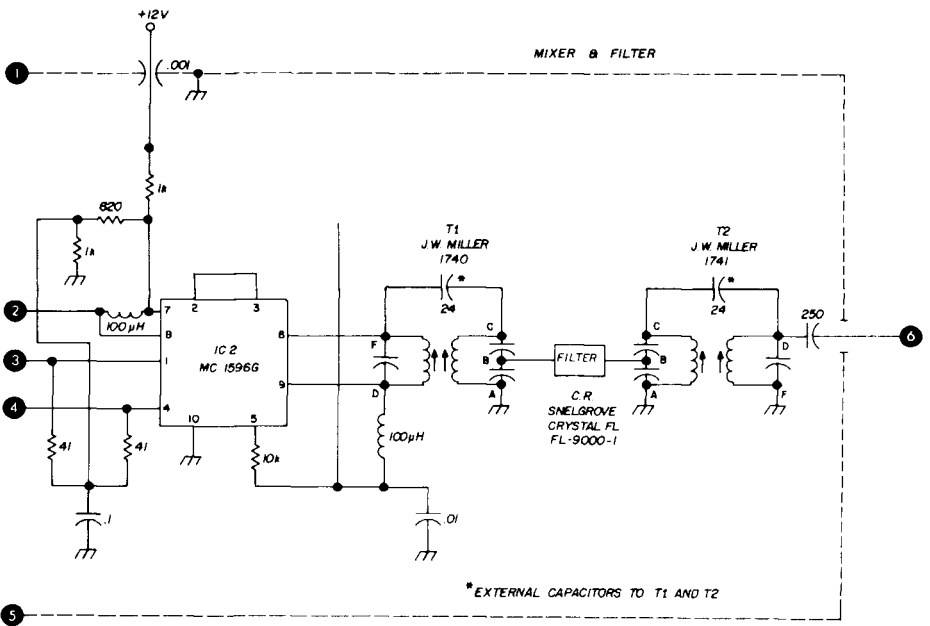
\* 1/4" GROMMETTED HOLES  
IN ALUMINUM BOX

fig. 3. Circuit diagram of the final design integrated-circuit 80-meter receiver. Power-supply circuit is shown on page 9. Bfo crystals Y1 and Y2 are furnished with the crystal filter. Author used Snelgrove FL-9000-1 crystal filter. However, KVG XF-9B or McCoy Silver Sentinel will work as well.

and output transformers, the balanced mixer configuration is the same as that described by K7WQR. The Miller transformers have low loss, provide sharp tuning and appear to match the crystal filter very well. The 24-pF capacitors across the transformer windings provide increased gain. These transformers

eliminate the complex problem of matching the input and output impedance of the crystal filter. Incorrect impedance matching severely distorts the passband of the filter; homebrewing these transformers is much too difficult for the average experimenter.

The 90-dB dynamic range of the



L1, L2 Cambion LS3-5 with 4-turn link or 25 turns no. 22 enameled on Amidon T50-6 toroid form with 3-turn no. 22 link

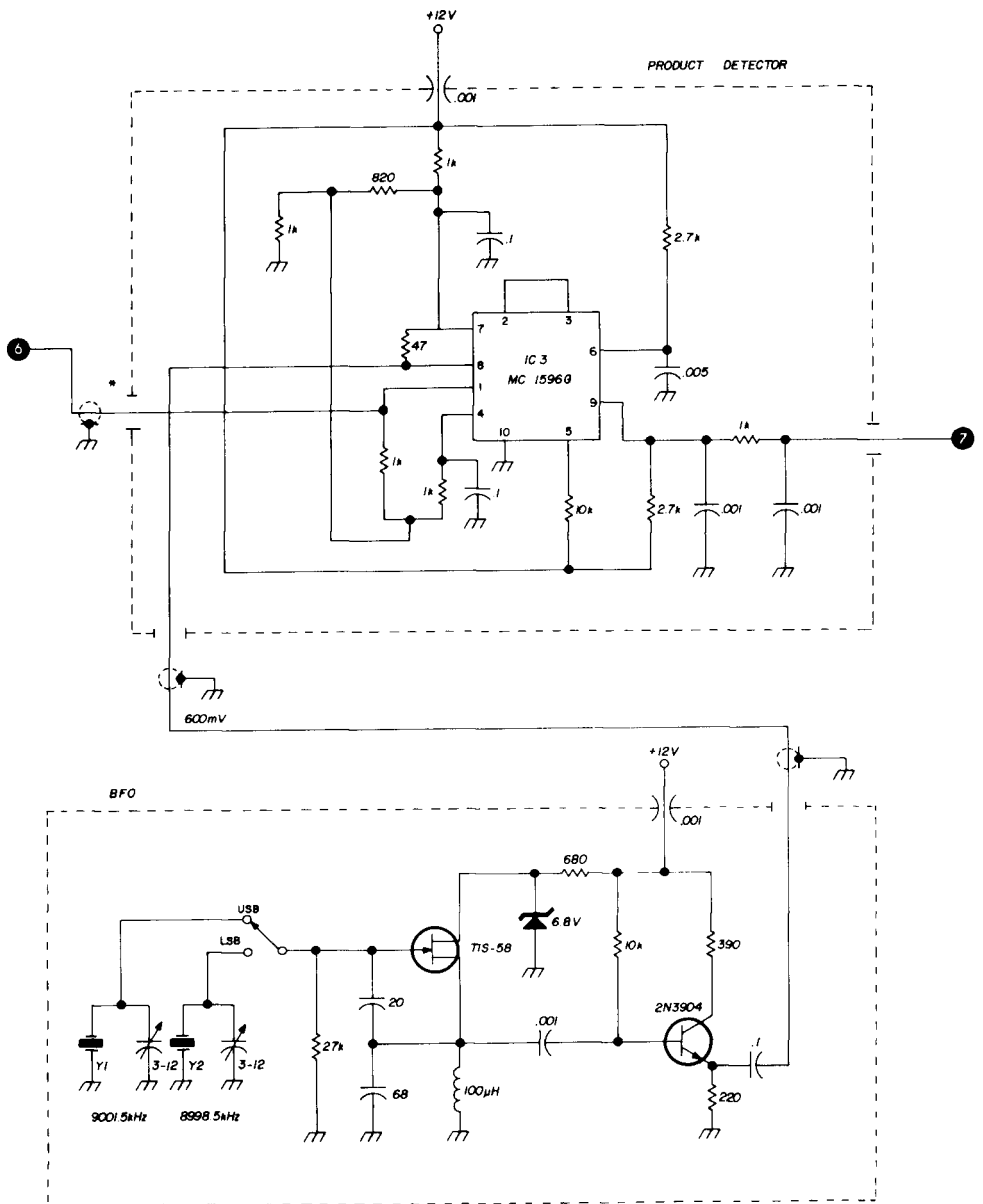
L3 14 turns no. 28, 5/8" diameter, slug tuned.

T1 ssb input transformer (J. W. Miller 1740)

T2 ssb output transformer (J. W. Miller 1741)

MC1596G integrated circuit makes the device relatively insensitive to input levels. This fact, coupled with the  $3\text{-}\mu\text{V}$  sensitivity and high conversion gain, makes the MC1596G the logical choice for the balanced mixer stage.

The only adjustments in the mixer/filter module are T1, T2 and the 50k null-adjustment pot. Transformers T1 and T2 are tuned for maximum signal. The null-adjustment pot is set for maximum 9-MHz signal at pin D of T2. These



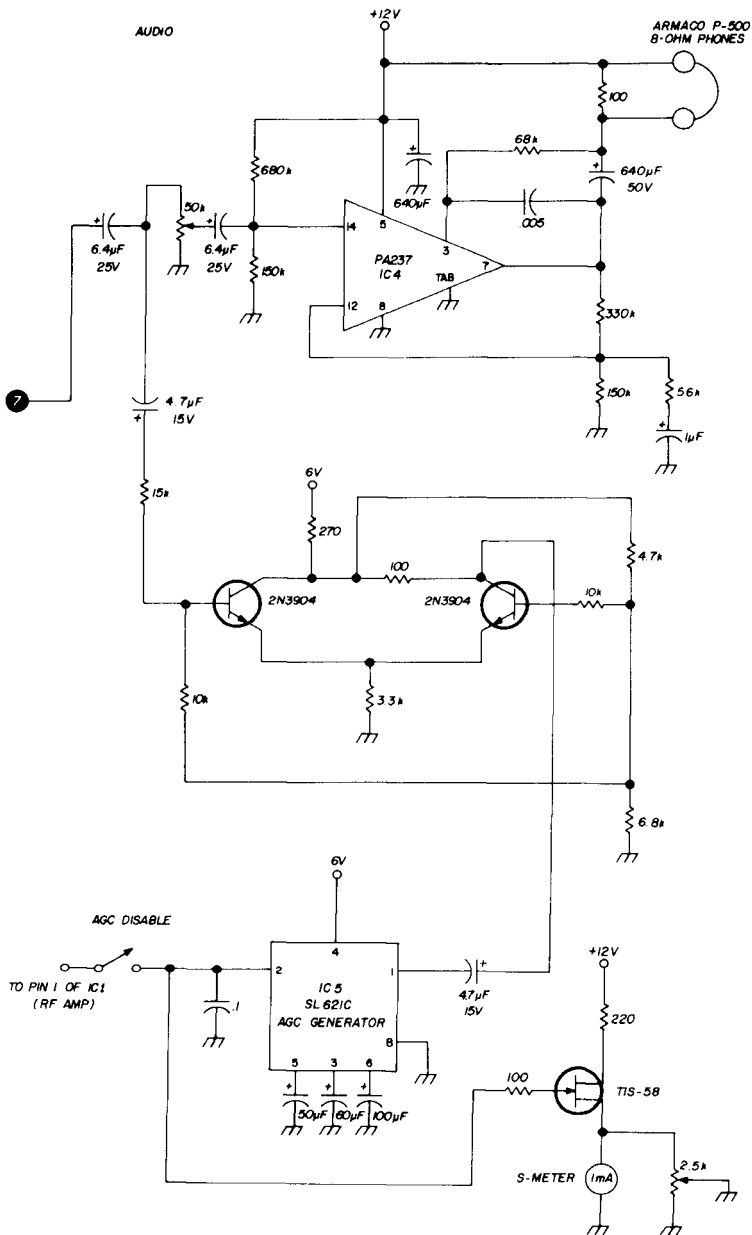
adjustments are quite simple as they are rather well defined.

### vfo

The vfo is basically the same as the circuit presented in the 1969 edition of *The Radio Amateur's Handbook*.<sup>3</sup> This vfo is extremely stable and the output waveform is clean and symmetrical. A bandpass filter is not required on the output because the high common-mode

rejection of the IC balanced mixer (typically 85 dB) eliminates any unwanted sidebands present in the vfo signal.

With this circuit vfo drift over a period of several hours was on the order of a few cycles per second. This far exceeds the requirements for this receiver. I have used this circuit several times, and the purchase cost of the 3N128 mosfet is well worth its performance and stability. How-



ever, to obtain good stability it is important to use a good quality double-bearing air-variable capacitor along with rigid mechanical design.

### product detector

The product detector circuit is essentially the same as that described by K7WQR. High-level signal performance and sensitivity is excellent; conversion gain is high, typically 24 dB. In fact,

performance of this circuit is so good, VE3GFN has discarded his hot-carrier diode product detector<sup>4</sup> and replaced it with this one.

### audio

The audio system uses another IC, the General Electric PA237. Although this IC should be used with a power supply of 24 volts for its rated output power of 2 watts, with a 12-volt power supply it

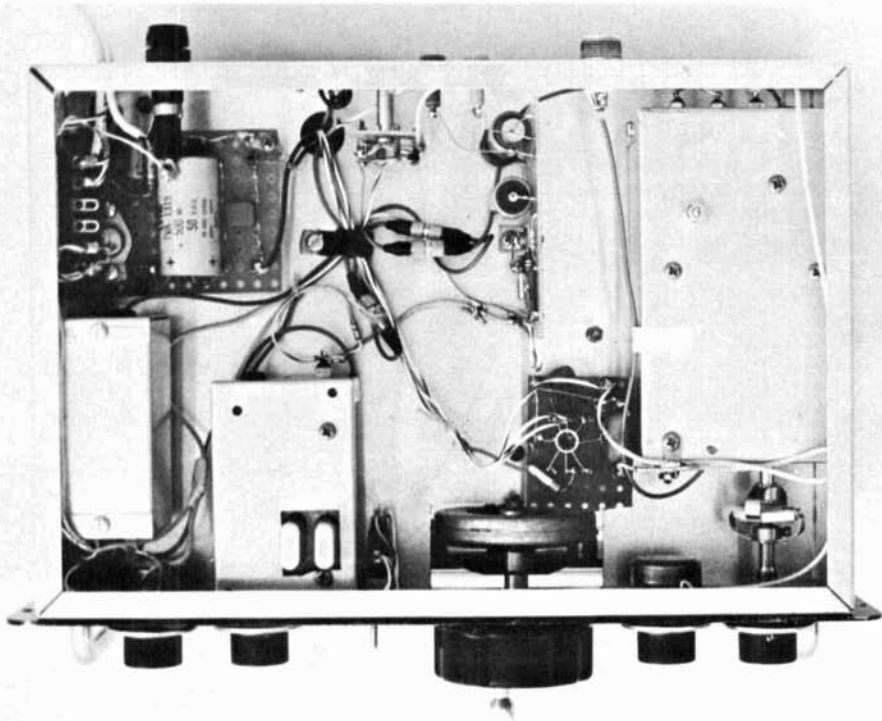
drives adequately a pair of Armaco P-500 stereo headphones. A less expensive audio system would probably result from using a consumer-rated audio-power IC such as the Motorola MFC9010.

### agc

The agc system is built around the SL621C agc generator manufactured by

a 110-dB range of receiver input signal. In my receiver the audio level holds within 4 dB for rf input signals up to 150 mV rms.

If you consider using the SL621C I recommend that you read the excellent article by W3TNO.<sup>5</sup> The input to the SL621C must be held to approximately 10 mV rms. In the circuit in **fig. 3** I have used W3TNO's method of accomplishing



Under the chassis. From left to right, front, product detector, bfo, agc generator and rf amplifier. Power supply is upper left. The audio output board is on edge in the upper center.

Plessey Microelectronics.\* This IC is designed to be used with the SL610C rf amplifier in ssb applications. As with other advanced agc systems, this integrated circuit generates the agc voltage directly from the detected audio waveform, provides a "hold" period to maintain the agc level during speech pauses and is immune to noise interference. When the SL621 agc generator is used in conjunction with the SL610 rf amplifier, audio level is maintained within 4 dB for

\*Plessey integrated circuits are available from Plessey Electronics Corporation, 170 Finn Court, Farmingdale, Long Island, New York 11735. The SL610C rf amplifier and SL612C i-f amplifier are \$5.65 each; the SL621C agc generator is \$8.30.

The following semiconductors are available from Circuit Specialists Company, Box 3047, Scottsdale, Arizona 87257. MC1496 (\$3.90), T1S58/HEP802 (\$1.59), 2N3904/HEP736 (\$1.28), 2N2219 (\$1.38), 2N3054/HEP703 (\$2.75), PA237 (\$4.30), 3N128 (\$1.74), 12-volt Z0222 zener (.70), 6-volt Z0215 zener (.70) and 1N4148 (.40). Please add 25c for shipping.

this: An emitter-coupled clipper to prevent the input capacitor from charging, and a resistive voltage divider to keep the audio signal at the 10 mV level required by the IC.

## power supply

The two voltage requirements of 6 and

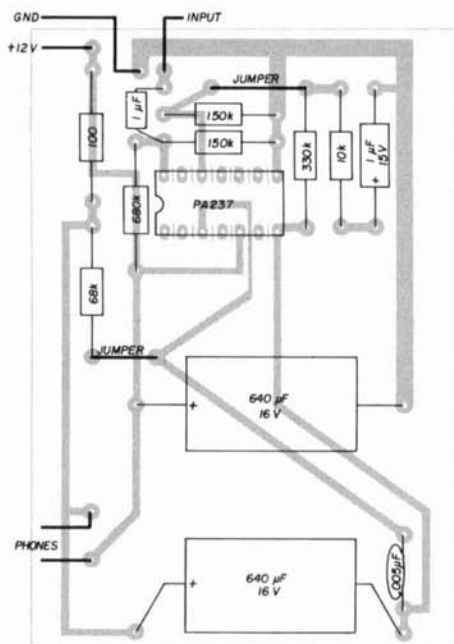


fig. 4. Printed-circuit layout for the 1-watt integrated-circuit audio power amplifier.

12 volts are derived from series-type voltage regulation (fig. 3). This method is quite good if a large amount of filtering is included in the circuit. However, for better regulation and less ripple you should consider one of the integrated-circuit voltage regulators that are available.

## performance

The sensitivity of the complete communications receiver is  $0.5 \mu\text{V}$  for 10-dB signal-plus-noise-to-noise ratio; this was measured with a Boonton type 65B signal

\*The spinner-type main-tuning knob shown in the photographs is not standard; it was machined by VE3ELP.

generator. No cross modulation was detected for input levels up to 100 mV rms. Frequency readout (with the Eddystone 898\* dial) is to 1 kHz; frequency error over the 500-kHz tuning range is 18 kHz.

## conclusions

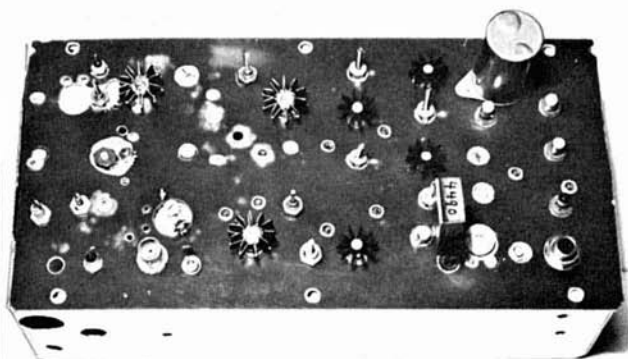
I plan to use other versions of this basic design in future homebrew receivers. One possible approach is to feed the antenna directly into the first mixer and use agc in the i-f section as in the W7ZOI design.<sup>7</sup> The Plessey SL612 integrated-circuit i-f amplifier is compatible with the SL621C agc generator and looks like an ideal choice. I am presently working on an all-band converter using the MC1596G balanced-mixer IC that will use this receiver as a tunable i-f from 3.5 to 4.0 MHz.

I would like to thank M. Goldstein, VE3GFN, and A. Martin for the photographs; I would also like to thank J. Riach, VE3DSR, for his constructive criticism.

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ham radio



## solid-state two-meter fm transmitter

This high-performance  
phase-modulated  
144-MHz transmitter  
features 8-watts output  
with a 12-volt  
power supply

Frank Jones, W6AJF, 850 Donner Avenue, Sonoma, California 95476

This two-meter fm transmitter is suitable for operation through the fm repeater stations which are located on a great many mountain tops. With an auto-battery power supply of 12 to 14 volts carrier output measures from 2 to 3 watts. A 24-volt supply to the final 2N3632 power stage will provide 7 to 8 watts of fm output. The 2N3632 transistors are not the most desirable type, but surplus devices were less expensive than the newer types which were available a year or so ago. Some 2N3632 transistors run wild and burn out easily when used with a power supply greater than 15 volts.

Phase modulation, converted to fm, is much easier to handle than a-m with transistor systems, and carrier output is about twice as high as that for a-m. The collector supply with amplitude modulation has to be reduced greatly with most power transistors to operate within the maximum allowable peak voltages. Ssb has the same problems. These modulation systems require power transistors with good linearity and peak voltage ratings more than four times the value of dc



supply.<sup>1</sup> Phase or frequency modulation requires that the peak voltage under load conditions be less than twice the dc supply value. This permits supply voltages two times higher and results in 2 to 4 times as much rf carrier output.

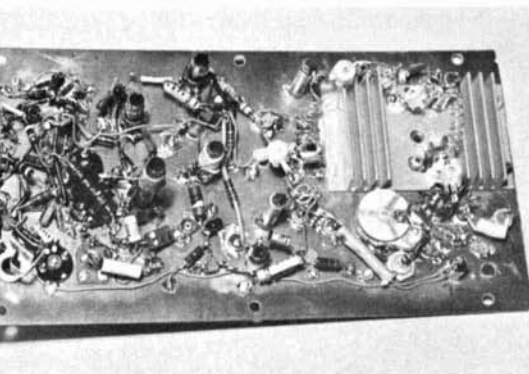
In an overall system with a good fm receiver (not slope detection) fm can compete with ssb in effectiveness; it may even surpass ssb for difficult paths on 144 MHz. Also, ignition and some power noises are suppressed much better by fm receivers since the limiters in an fm receiver which remove a-m also knock off noise pulses at the carrier level. This cannot be done in an a-m or ssb receiver without some pretty sophisticated i-f noise blankers.

This transmitter has been in intermittent service for over a year with a repeater which is behind a small mountain range. It is not line of sight, and the "knife-edge" diffraction effects are very poor in the direction of my station. The previous 1-watt fm transmitter wouldn't do the job even with a 10-dB gain antenna. This transmitter usually does the job.

### phase modulator

The phase modulator uses a pair of varactor diodes — rectifiers normally used for small power supplies. The 1N645

Inside the fm transmitter. Rf power output transistor is stud-mounted to the large heat sink on the right. Mounting chassis is 3x5x10 inches.



rectifier has some variable capacitance effect with variations of audio voltage when the diodes are reverse biased with a few volts. Nearly any small power rectifier with very high back resistance will work in this circuit. Some types have much higher resting capacitance and require a smaller shunt inductance to resonate at 4.6 MHz.

The 1N645s in series work with a slug-tuned coil (from an older type broadcast receiver) since the total shunt capacitance is only a few picofarads. The untuned crystal oscillator is lightly loaded through a 2-pF capacitor. The crystal can be zeroed in on a desired frequency if it is slightly off by means of a variable capacitor from one side of the crystal to ground.

The phase modulator LC circuit should be used to drive a high input impedance class-A amplifier through a 1- or 2-pF capacitor. Actually, it can be used to drive a frequency doubler without too much distortion if the rf output requirements are moderate. In the circuit shown in **fig. 1** frequency doublers are used throughout; in the first few doublers the power requirements can be met with small surplus transistors of the 2N706 or 2N708 class. The 2N5188 power transistor can be made to work up to 148 MHz but it will not put out much over 250 or 500 milliwatts since a 12-volt power supply is near its maximum rating. The 2N5188 is in the half-dollar price range from RCA distributors.

This type of frequency-doubler drive circuit has proven to be much superior to inductive-coupled circuits. The capacitance dividers step the tuned-circuit impedance down to 50 ohms or so to work into the base of the next stage. The large capacitance across the base acts as a low impedance of a few ohms at the doubled output frequency. Without a low-impedance path from base to emitter the collector-to-base capacitance will feed back enough energy to greatly reduce output power.

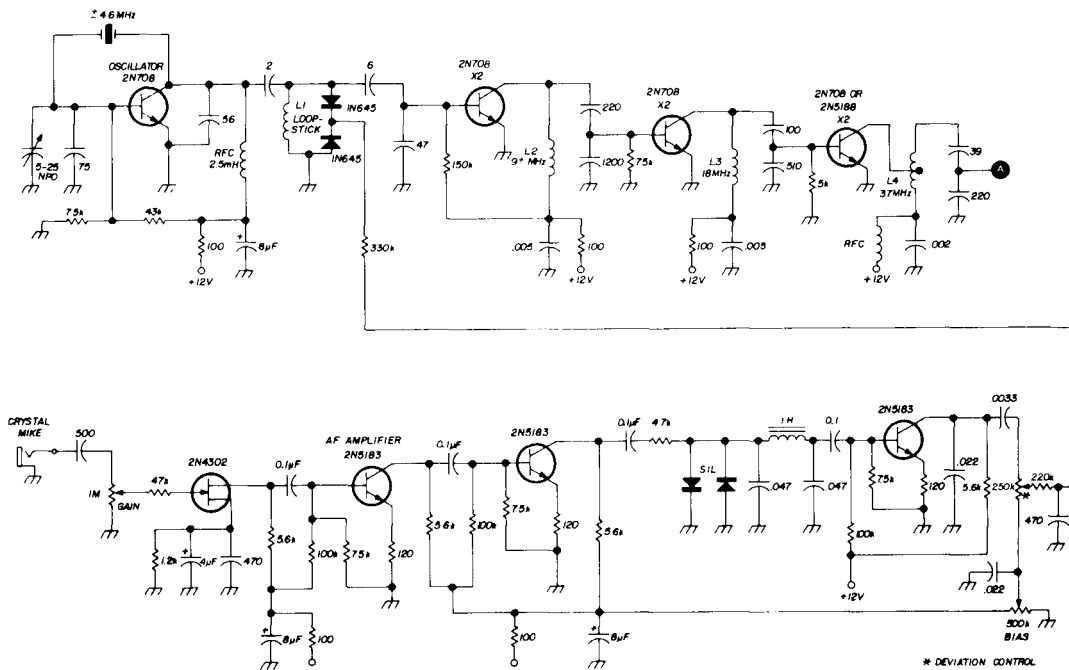
This frequency multiplier design saves dc power and transistor heating, and

permits considerable latitude in choosing transistors. For maximum efficiency the transistor should have a cutoff frequency rating of 5 to 10 times the operating frequency. The 2N5188 is operating too

2N3632 which costs less on the surplus market.

## rf amplifiers

The rf amplifier circuits were chosen



close to its cutoff frequency for good efficiency as a two-meter doubler, but some devices work reasonably well as two-meter amplifiers.

The lower-frequency doubler stages are not as critical, so I moved the transistors around for best overall drive to the final amplifier. One 2N5188 worked fairly well in the 144-MHz 2N3553 stage (at 1/10 the cost) with only a 12-volt power supply; the 2N5188 will not work at higher supply voltages. However, this transmitter is normally used with a 12-volt storage battery so the 2N5188 is used most of the time in the 144-MHz stage to save the more expensive 2N3553 for other uses. (The 2N3553 makes a good final amplifier with a 24- or 28-volt supply providing 5 to 7 watts output.) With a 12-volt supply power output is less than 2 watts, somewhat inferior to the

from a standpoint of less parasitic oscillation and transistor burnout than other circuits I've tried in previous transmitters. The little power transistors are real monsters unless the base-to-emitter path is just right. A small rf choke consisting of 5 or 6 turns of wire on a lossy 1/8-inch diameter ferrite rod makes about the best dc path from base to emitter. If the rf driving power is large enough, a 10-ohm carbon-composition or carbon-film resistor can be used for this dc path in place of the ferrite-core rf choke.

The more rf and dc power into and out of a transistor, the lower the input and output impedances. You can expect values of 2 to 10 ohms in the output stage. This makes it difficult to match impedances to the driver and the antenna circuits.

As shown, with only one tuned circuit,



# crt intensifier for RTTY

A simple circuit  
for intensifying  
the RTTY monitor scope  
during receive

Radioteletype is a very interesting facet of amateur radio, and equipment is often designed for the highest degree of automation. When using an oscilloscope as a tuning aid there is no problem of beam brilliance as long as the beam is being deflected by the incoming mark and space signals. The beam can be adjusted, using the intensity control, for proper brilliance with signal. However, a problem arises during RTTY operation when no-signal periods occur—the beam is not moving, and screen brightness becomes very intense. Unfortunately, the high intensity spot will burn the screen if the intensity control is not turned back.

The inconvenience of monitoring beam brilliance and continually making adjustments to save the cathode ray screen led me to look for a system that would accomplish this function automatically.

The desired circuit for controlling cathode-ray-tube bias should OR the mark and space signals so that if either is present the grid bias on the cathode ray tube is lowered, and the signal pattern is displayed.

Two requirements are necessary for controlling cathode-ray-tube bias. First, the bias must not get low enough to cause the electron beam to bloom (get out of focus). The beam focus point changes when the beam current passes a certain point, and this must be avoided. The maximum positive voltage that the control circuit can apply to the grid of the tube must be limited to a maximum that will not cause blooming of the beam.

Second, the control circuit should have some degree of proportional control when the incoming mark and space signals begin to fall below the level at which limiting takes place in the RTTY converter and the display on the cathode ray tube screen begins to shrink. As the display begins to shrink and beam travel speed is reduced, screen brilliance will increase due to the reduced area of illumination. The increase of brilliance with reduced display size points out the desirability of a brightness control that is proportional to display size when signal levels fall below the limiting levels of the RTTY converter.

## the circuit

A circuit which will provide brightness control of the cathode ray tube during typical RTTY signal conditions is shown in fig. 1. The intensifier circuit is con-

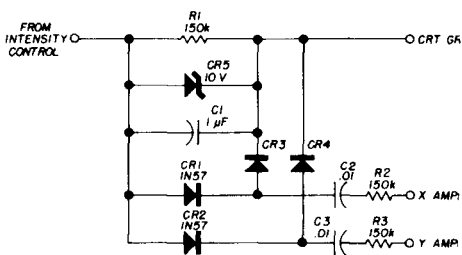


fig. 1. Schematic of the CRT intensifier. Value of CR5 is discussed in text.

Heard Lowry, K4VFA, 915 Madison Street, Manchester, Tennessee 37355

nected between the brightness control and the cathode-ray-tube control grid. It is activated by space and mark signals from the oscilloscope's X and Y amplifiers. Loading on the X and Y amplifiers is reduced by the 150k resistors R2 and R3. Coupling to the X and Y channels is provided by C2 and R2 to the X amplifier and C3 and R3 to the Y amplifier.

## operation

The dc intensification voltage is developed across R and C. The peak intensification voltage is set by the 10-volt zener diode, CR5, and limits this voltage to a safe value which will not cause blooming

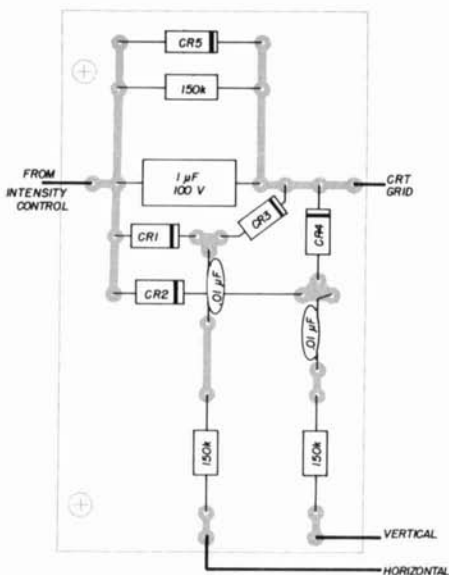


fig. 2. Full-size printed-circuit layout for the CRT intensifier.

of the beam during intensification. Selection of the zener diode as well as suggestions for particular applications will be discussed later.

The rectifier circuits from the X and Y oscilloscope channels consist of voltage-doubler circuits. The X circuit is made up by CR1, CR3, and C2, with C1 and R1 common to both the X and Y channels. The Y circuit consists of CR2, CR4 and C3 with C1 and R1. The X and Y signals

feed into their respective doubler circuits; the highest signal, mark or space, sets the voltage level until the zener diode begins to conduct and limit the voltage to a peak brightness level. The time constant for the brightness level is determined by C1 and R1. By varying C, the length of time is controlled during which intensification is extended.

## construction

To determine the required zener voltage for particular scope the following procedure is recommended. A high-impedance voltmeter is connected between the grid number 1 and the cathode of the CRT. (*Caution.* High voltages are usually involved, so do not change connections or touch the voltmeter while power is applied.)

The first measurement is obtained by applying power to the scope without mark or space input signals. (This should produce a spot.) Reduce intensity until the spot is completely extinguished; then read and record the voltage. The next reading is made with both mark and space signals applied, the CRT showing a cross display. Adjust the brilliance until a pleasing display intensity is obtained; then read the voltmeter and record this reading. To obtain the zener voltage rating subtract the second reading from the first; a quarter-watt zener diode with this voltage rating will provide good results.

The CRT intensifier can be built on a small printed-circuit board or Vector-type perforated board. Or, you may mount the components on two or three terminal strips which have been installed at convenient spots on the scope chassis. Fig. 2 shows a printed-circuit layout which includes mounting holes. This layout is small enough so that no trouble should be experienced in finding a suitable location within your scope. The board can be vertically mounted with L-shaped brackets. If the circuit board is mounted inside the scope give proper consideration to lead length and proximity to other components.

ham radio



## superior phone patch

A legal phone patch  
with many  
desirable features  
including complete  
operator control

Hybrid circuits to interconnect the amateur station and a commercial telephone circuit are not uncommon, both in kit form and assembled. Most such phone patches, however, have a number of disadvantages. These include the necessity of using the telephone handset, which frequently over-drives the transmitter; complex procedures to go from normal operation to patch and return; and unsatisfactory vox operation.

### features

The unit described in this article overcomes the problems mentioned above and has additional desirable features. The operator can talk to either party — telephone or radio — together or selectively, using the station microphone and headset or speaker. He is in complete control, with ability to cut off or override either party at any time. Changeover from normal operation to patch and back is simple and fast. Finally, it is possible to record all three parties' conversations and play the recording back to telephone, radio, or local monitor.

A block diagram of the system is shown in **fig. 1**. Even without the tape recorder connections, which are omitted, it is apparent that each input — transmitter, telephone, and monitor — receives signals from two sources; and some form

R. B. Shreve, W8GRG, 2842 Winthrop Road, Shaker Heights, Ohio 44120

of hybrid or other isolation is required to keep the signal originating at one source from feeding back to the other. However, the only place where input and output circuits have common terminals is the

simpler circuit at no greater cost. The amplifiers are Motorola MC 1439Gs — internally protected against input overload, latch-up, and output short-circuit; and they're relatively inexpensive.

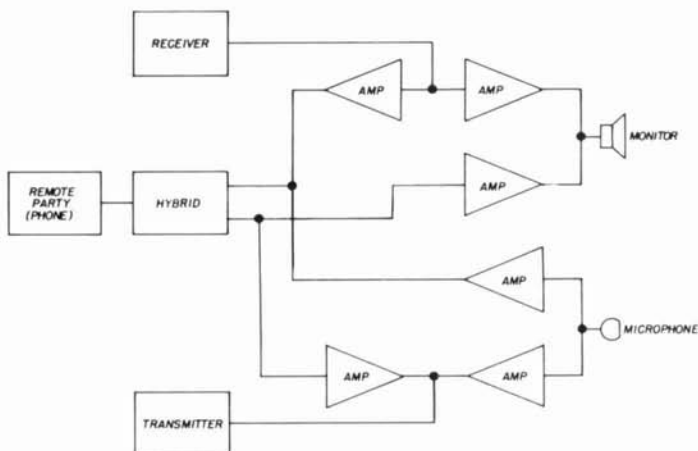


fig. 1. System block diagram. Each input receives signals from two sources; feedback is eliminated by hybrid circuit and amplifiers.

phone, so this is the only place a hybrid is required. The rest of the isolation can be accomplished with amplifiers, indicated by triangles in the diagram.

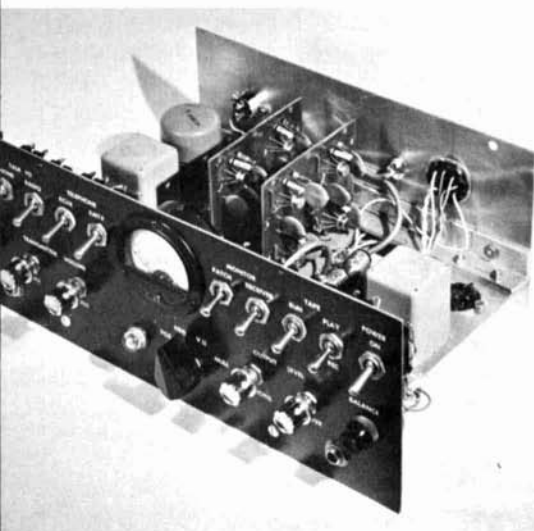
The original version of this patch used transistors and other discrete components. The present model employs IC operational amplifiers, resulting in a

Connections for a typical audio amplifier are shown in fig. 2. The model shown is an inverting amplifier, with signal input at the inverting (-) lead and the noninverting (+) lead grounded. It is stabilized by 0.1  $\mu$ F bypass capacitors at leads 4 and 7 and a compensation network between leads 1 and 8. Values shown are recommended by the manufacturer for unity gain; they work well for all gains and frequencies encountered in the phone patch. This compensation is applied to all seven amplifiers in the patch but is omitted from the schematic (fig. 3) for simplicity.

Gain is determined by the ratio of  $R_F$  to  $R_I$ ; and a feedback capacitor,  $C_F$ , is added to three amplifiers to suppress unwanted high-frequency response.

### circuit

In fig. 3, T1 and T2 form the hybrid. I use a pair of UTC transistor/line transformers, type A-22, which have split secondaries with 250 ohms impedance on each half, and 500-ohm center-tapped primaries. The secondaries are cross-connected so that a signal injected into one



primary is balanced out in the other transformer. These transformers work very well, but those wishing to build a similar unit from scratch may want to try a transformer with a higher-impedance primary for T1, and possibly eliminate the two 470-ohm resistors I had to put in series with the amplifier outputs to make them work properly.

T3 is a one-to-one isolation transformer with from 500- to 1000-ohm impedance each side and a third winding that provides a signal for the tape recorder input and VU meter.

The pad between the hybrid and T3 presents a relatively constant impedance to the hybrid, facilitating balancing with

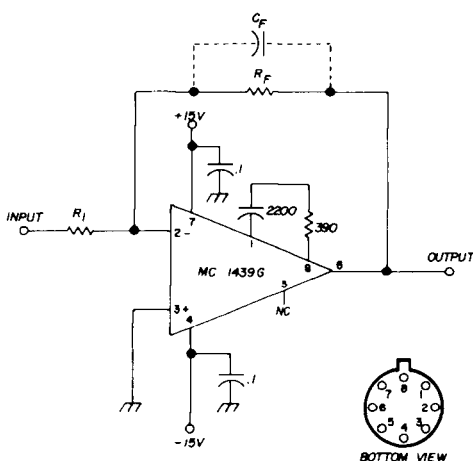


fig. 2. Terminal connections and compensation for a typical IC audio amplifier.

the 1k variable resistor. Good balance is essential if vox operation is desired.

### amplifier considerations

As mentioned earlier, the power supply and compensation connections to the amplifiers have been omitted from the schematic for clarity. Amplifiers 1, 4, and 6 are simple inverting models, with adjustable gain controlled by varying their feedback resistances. The .001- $\mu$ F feedback capacitors on amplifiers 1 and 6 suppress an approximately 25-kHz oscillation that appeared when the unit was

connected to one of my station receivers; others may not find them necessary.

Amplifier 5 is similar; but instead of adjustable gain, it has an RC network in its feedback circuit to make it an active filter as well as an amplifier. Signal level from the receiver to the phone line is controlled with the gain controls on the receiver.

Tariffs of many Bell System telephone companies, in addition to limiting the strength of the signal that may be transmitted over their lines, require that devices connected to the lines through their voice coupler have minimal output at 2600 Hz and above.<sup>1, 3</sup> The circuit shown has a maximum voltage gain of 10 at approximately 1000 Hz and practically no gain at 400 and 2000 Hz. This narrow bandpass admittedly sacrifices some voice quality, but intelligibility seems to be generally good. The circuit eliminates a lot of heterodynes and other interference and keeps the telephone company happy as well. Those desiring a broader bandpass, while still meeting phone company requirements, might try a two- or three-stage biquadratic filter<sup>2</sup> in place of amplifier 5.

Amplifiers 2 and 3 were originally constructed similarly to the others, but two problems resulted. First, with the microphone and the feedback resistor both connected to the inverting input of amplifier 2, the receiver output to T1 from amplifier 5 fed back around amplifier 2 to the input of amplifier 3 and the transmitter, which defeated the purpose of the hybrid. To correct this, amplifier 2 was connected as a noninverting amplifier, with the microphone input to lead 3 and feedback to lead 2.

Furthermore, the high gain needed in amplifier 2 to amplify the microphone signal to phone-line level makes the shielding of the microphone leads to amplifiers 2 and 3 critical. The circuitry used permits mounting both the input and feedback resistors directly on the circuit boards, minimizing lead length and simplifying shielding.

Amplifier 7 is a meter amplifier. Positions 1 and 2 of the meter switch (S11)

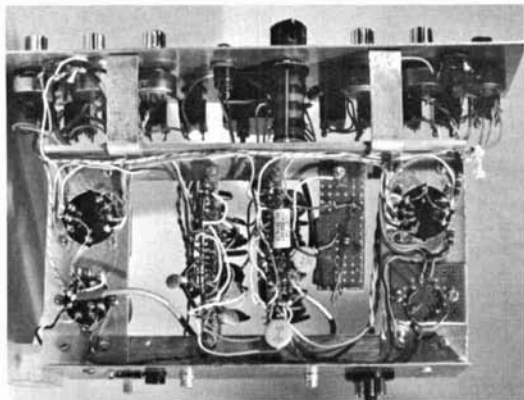




the monitor output when patch power is off. S11, the meter switch, was described above. A 28-volt pilot lamp is connected between V+ and V-, providing visual indication that both sides of the supply are on.

## construction

The unit is built to mount in a station control console. The controls, microphone input, and monitor output are on



Construction of the superior phone patch.

the front panel. The back panel has a two-contact Jones plug for the telephone line, phono jacks for outputs to transmitter and tape recorder, a single pin jack for the push-to-talk lead to the transmitter, and an octal plug for the remaining connections, including ground.

Amplifiers are mounted on two etched circuit boards, four on one and three on the other. These boards plug into 22-contact mounting strips attached to the bottom frame, which made it easy to remove the boards for experimental component changes during development. A metal strip across one end of the frame holds two transformers; the other, together with the H pad, is on a similar strip across the other end of the frame. Space was left on the frame for two more circuit-board mounts. One will be used to mount a VOX circuit that will control a vhf fm transmitter, and the other will permit installation of the three-unit

biquad low-pass filter mentioned earlier if it proves to be desirable. The entire assembly was made from sheet aluminum and do-it-yourself strips and angles using home tools.

## operation

For normal operation without a third party on the telephone, the TALK TO RADIO (S3) and MONITOR RECEIVER (S7) circuits are on. To set up a patch, S1 is turned on, the telephone circuit is activated, TALK TO PHONE (S2) and MONITOR PATCH (S6) are turned on, and S3 is turned off to keep the preliminary phone conversation off the air. Telephone contact is established using the station microphone and monitor. S7 may be turned off if signals from the receiver make it difficult to hear the party on the phone.

Contact between the parties is established by turning on the TELEPHONE RCVR (S4) and TELEPHONE XMTR (S5) switches, and proceeds with vox operation unless the telephone party trips the transmitter too often with laughter or interruptions. With S2 and S3 off, the operator can carry on another conversation or monitor another receiver without fear of interrupting the patch, but can monitor and break in if necessary.

I was tempted to title this article "an ideal phone patch" after several contacts, but the patch isn't—quite. The ideal patch would have constant level output to telephone and transmitter regardless of input source or signal strength. So far I have been unable to develop or find an agc circuit to accomplish this with operational amplifiers. I'd like to hear from the ham who has.

## references

1. George P. Schleicher, W9NLT, "Phone Patching—Legitimately," *QST*, March, 1969, p. 11.
2. Motorola, Inc. Semiconductor Products Division publication "Motorola Integrated Circuits for MODEM and Terminal Systems" Section 4—"Op Amps and Active Filter Design," July, 1970.
3. J. B. Berry, Jr., W4PME, "Legalize Your Phone Patch," *QST*, May, 1969, p. 17.

ham radio

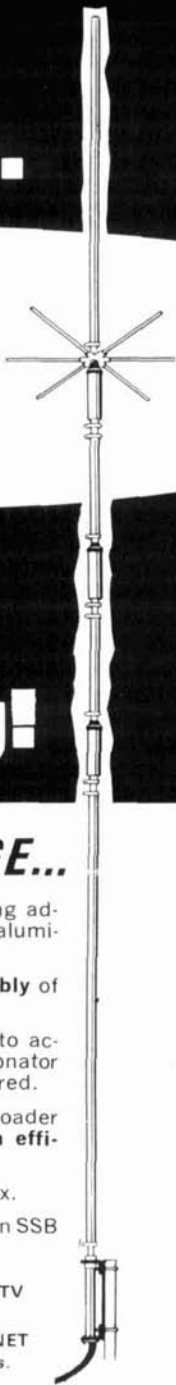
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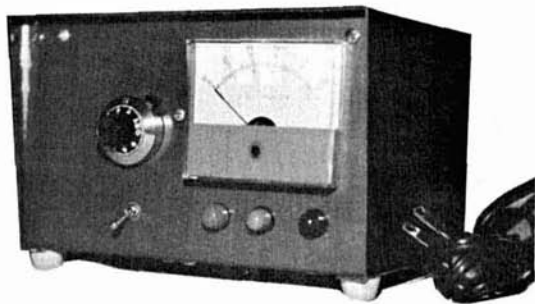
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## precision power supply

Looking for a  
laboratory-quality  
power source  
for your IC projects?  
Here's a  
likely candidate

After building many solid-state projects, I learned some interesting things about power sourcing, so I decided to build my own power supply. The little dandy shown on these pages is presented with the hope that others will benefit from my experience in this area.

First a "wish list" was made detailing everything the supply had to do to justify

the investment of time and material. An axiom is in order at this point: More semiconductors are destroyed during circuit testing and trouble shooting than expire from intrinsic device failure! The principal cause of such destruction is over-voltage. So, heading the list is:

1. Variable voltage sourcing.
2. High-resolution voltage control with constant-current over the full range, and accurate resetability.
3. A high-resolution voltmeter, with 1% accuracy over the complete range.
4. Current-limiting control regardless of voltage setting.
5. Regulation better than .01 percent.
6. Ripple less than 50 mV.
7. A signalling method to identify which voltage range is being metered (a paramount requirement — a try at idiot-proofing!).
8. Sufficient reserve current to power the most ambitious solid-state projects.
9. Small size and the capability of operating continuously at full load.

The schematic of **fig. 1** shows the circuit.

Alan Nusbbaum, W7SK, 3627 East Highland Avenue, Phoenix, Arizona 85018

## the regulator

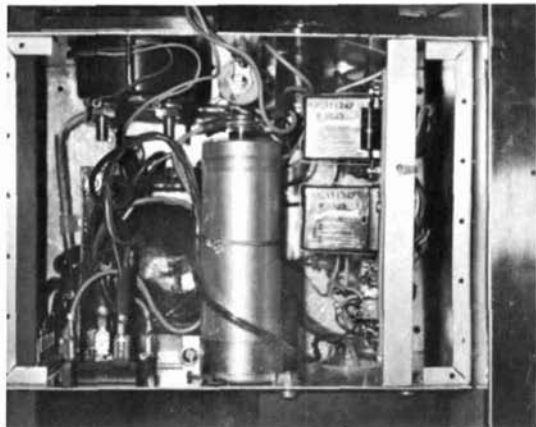
The Motorola MC1569R regulator IC was chosen because it satisfied the largest part of the regulation demands in one package. The MC1569R has a large power-handling capability, with a through-put current of 500 mA. Thus it was necessary to drive the low-beta series-pass transistor, Q1, to full saturation. The MC1569R will tolerate 36 volts input with safety. The circuit includes a voltage-control network consisting of a simple arrangement with a fixed 6.8k biasing resistor in combination with a 50k, 10-turn pot. This allows the output to be varied between 3.4 and 28 volts.

Still another attractive feature is the current-limiting ability, achieved by an external biasing transistor, Q2. Perhaps the most important feature is that the regulator won't oscillate (a plague affecting all high-gain op amp devices).

Two versions of this IC are available: the MC1469R with a rating of 35 volts maximum input; and the MC1569R, which has a maximum rating of 40 volts. If you choose a maximum of 34 volts to pin 3, the MC1469R will be more satisfactory.

The letter "R" denotes a TO66 package — do not use the "G" package (TO5 can) in this application, as its output is limited to 200 mA.

**Underchassis view. The large 3300-uF, 45-Vdc electrolytic capacitor dominates the scene — essential for eliminating input transients to the regulator.**



The variable-voltage control resistance (R1 in fig. 1) is determined by  $R1 = (2V_O - 7) \text{ k ohms}$ , which extrapolates to 53k ohms.\* However, the nearest standard 10-turn pot is 50k, thus limiting the highest voltage to about 28 volts (minus the saturation voltage of the regulator transistor). Do not add any fixed resistance in series with this pot (R1), as it will increase the minimum voltage far above the useful range of RTL devices; i. e., 3.6 volts.

## circuit description

Starting with the input to the series-pass regulator transistor (a Motorola 2N3771), the powering of all systems is done from 36 volts at the collector of this transistor. The output, or emitter, has an Ohmite 1.0-ohm pot (part no. 0101) in series with the load and a current-sensing transistor connected across this pot. This pot is set to sense 2 amperes. You'll note that an IR drop across this resistor upsets the  $V_{be}$  drop of the transistor (a 2N2219), causing the collector of this transistor to pull current from pin 4 of the MC1569R. This, in turn, drops the voltage output of the regulator, thereby biasing the 2N3771 base voltage down so that excessive current cannot be drawn—a Rube Goldberg action, but still a simple and effective means of device protection. A few words later about setting this potentiometer.

## meter and lamp switching

In the 3.4- to 10-volt range, the green lamp is lit and the 0- to 10-volt scale of the meter is the relevant range. When the multiturn pot is rotated upwards, approaching 9.5 volts, zener D1 and its related voltage-offsetting diodes begin to conduct current via two paths. One is through D3 and D4 to ground; the other and lower offset path is through D2 and the Darlington pair transistors (Q4,Q5). At the point where the zener abruptly avalanches, the sum of all voltage drops through the second or lower offset path is

\*Symbols used in this article are:  $V_O$  = output voltage;  $V_Z$  = avalanche (zener) voltage;  $V_F$  = forward voltage. *editor*

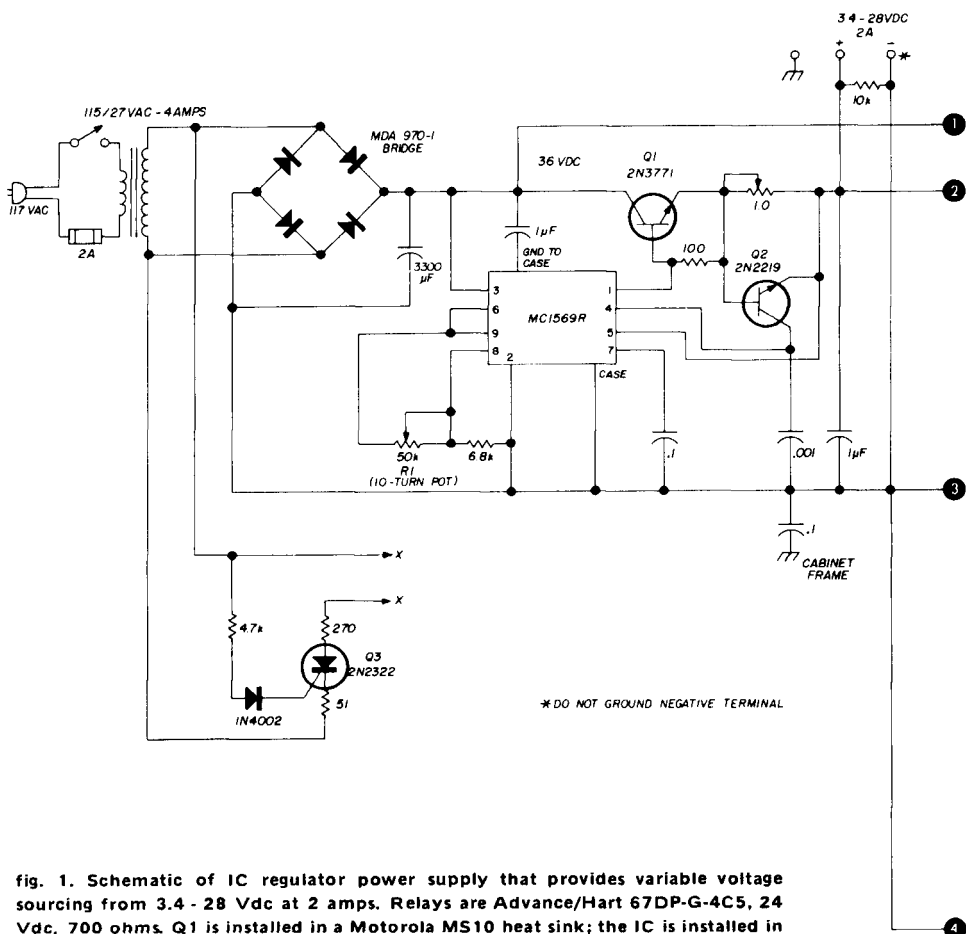


fig. 1. Schematic of IC regulator power supply that provides variable voltage sourcing from 3.4 - 28 Vdc at 2 amps. Relays are Advance/Hart 67DP-G-4C5, 24 Vdc, 700 ohms. Q1 is installed in a Motorola MS10 heat sink; the IC is installed in a Thermalloy 6168B heat sink.

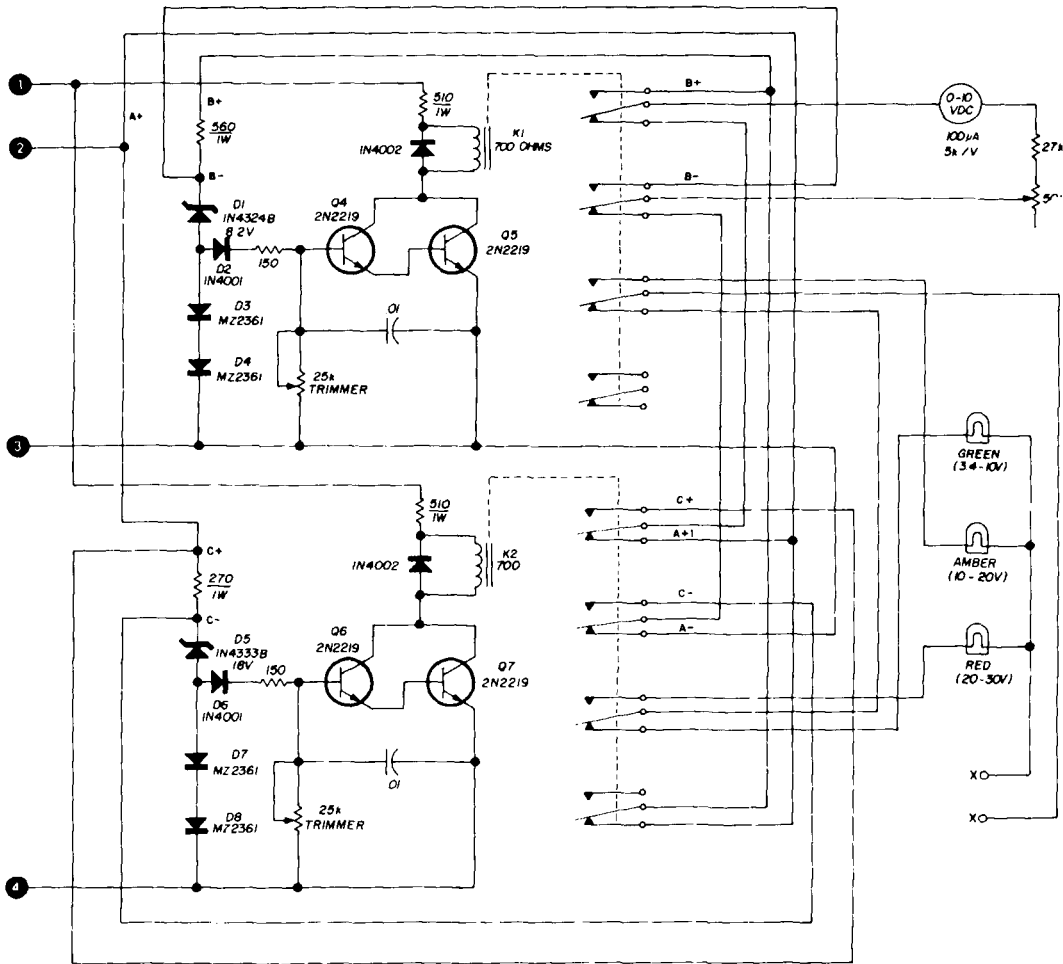
equal to 10 volts. This network divides off excess current on each scale when the voltage is set near its upper range. Due to variations in beta of the 2N2219 (Darlington), the base biasing trimmer resistor may require adjusting.

A 25k trim pot in this circuit sets the proper toggle sensing of this network. When the 10-volt level actuates the Darlington-pair relay driver, the activated relay switches lamps from green to amber, and the metering shifts from 0-10 to 10-20 volts (full scale). This is accomplished by switching the negative side of the meter from ground to the cathode of the zener, so as to read the product of

$I^2R$  across the zener loading resistor on the 10-20 volt scale.

One may question the accuracy of such reading in view of the nonlinearity of most zeners. However, by using a 1-watt, 2% zener packaged in a metal can, the  $V_Z$  will remain stable provided the current is held within the maximum dissipation of the device. By not heating the zener, we avoid the effects of impedance change in the device. Meter comparison checks with a Simpson 270 showed no difference in scale accuracy.

As the voltage-control pot is again elevated, the next-level voltage shift energizes the second relay, disabling the



first sensing stage to conserve current. The indicator lamp shifts from amber to red, and the metering shifts from 10-20 volts to 20-30 volts (full scale), with readings taken across the second zener loading resistor. (Incidentally, this could continue ad infinitum.)

The meter has a 200-microampere movement at  $5k \Omega/\text{volt}$ . A fixed  $10k$  series resistor plus a  $50k$  trimpot sets the full scale to 10 volts. It reads all scales with this one setting — set and forget.

### fine sensing control

You will note another trimpot in the base lead of the second Darlington switch. Again, variations in betas plus minute differences in  $V_F$  levels of the diodes dictate a fine tuning of the sensing network. Once this pot is set and the network shifts at 20 volts, the pot needs no further attention.

There will be some residual hysteresis when the voltage passes through switching levels. This is desirable, as it elim-

inates ambiguity in meter setting when voltages are set near the threshold of level change. The hysteresis is about 150 millivolts; but with regulation better than this figure, there will be no "hunting" when the supply is loaded and unloaded in fast sequence, such as with a pulsed load.

## heat dissipation

The 2N3771 is used as a variable, electronically controlled rheostat, which in this application must dissipate considerable power in the form of heat. Let's consider a worst-case situation to show how much power we must sink off as heat.

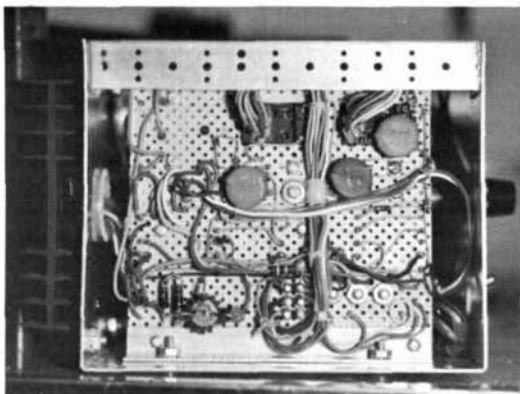
The input voltage to the 2N3771 is 36 volts from the rectifier-filter stage. The voltage control is set for 4 volts and we intend to use 2 amps from the supply. Therefore, we must drop 34 volts through the transistor, while it must pass 2 amperes or a total of 68 watts at 75° C. However, we're operating at 50% of the rated power load (150 watts at 25° C); but this is still a lot of heat to be cooked away — (try holding a 75 watt lamp bulb!).

One of the cardinal rules of transistor design is: "To prevent thermal damage, the heat extracted from the device must equal or exceed the heat generated." Therefore, an adequate heat sink for this transistor must be used, or else the safe operating area will be exceeded and the device will be instantly destroyed, even though it is running at 1/2 its rated power. In this application, a Motorola MS10 heat sink is used. Remember, it's the product of voltage drop and current that equals power-dissipation requirements!

This supply has been run on a heat test for 24 hours at 1/2 load without failure, although the cabinet was quite warm. A reading with a precision thermometer indicated nearly 75° C (167° F) at the edge of the sink — still safely within tolerance. Most tabletop projects don't require this amount of current, but it's nice to know you have a supply with a substantial reserve of power, just in case.

## adjustment

To set the current limiting pot, first set the control, wired as a rheostat, at the 25% point or roughly 1/4 ohm. Then connect a 25-ohm, 100 watt adjustable bleeder resistor, set to 20 ohms, across the output terminals of the supply. With the voltage control set for 25 volts, slowly reset the bleeder to 13 ohms. Then increase the rheostat resistance to a point



Side view showing circuit-board components.

where the supply automatically switches to a lower voltage range, indicating current limiting.

Now reduce this control resistance until the voltage returns to 25 volts (at 13 ohms bleed) and quickly disconnect the load while watching the voltmeter. If the voltage shifts up or down, carefully fine-tune the current-limiting control while momentarily touching the load to the supply. Then when the full load-no-load voltage remains constant, this sensing control is in balance. Reduce the disconnected bleeder resistance to 10 ohms and attach the bleeder to the terminals as a check for supply shutdown, which should occur instantly. Lock the control shaft, and the supply is ready to operate.

I installed this control inside the cabinet, so that it can't be disturbed; it can, however, be mounted with the shaft extended and a knob installed for variable



current-limiting control from the front panel. Calibration and marking would be a simple task.

One last word about the MC1569R regulator. A small T066 heat sink is necessary to keep the temperature within bounds. A Thermalloy 6168B is suggested for this application.

### construction notes

The supply was built in a 5 x 6 x 8-inch LMB aluminum box, with the circuit board mounted on the left side. There's nothing exotic about the assembly of the supply or wiring of relays and circuit-board devices. Number 22 teflon-covered wire (surplus) was used for these components. The high-current leads from the bridge rectifier to the pass transistor, then to the output binding posts, were no. 14 teflon-coated wire.

The output binding posts are spaced on 3/4-inch centers to accept Pomona-type ganged plugs. Three terminals are used, with the green post internally connected to the chassis, as both positive and negative leads are ungrounded.

### conclusion


This supply has been a pleasure to use and has been indispensable in the construction of IC device projects — I'm sure it will be the same for you.

Those interested in further information in this application of ICs will find the material in the references very helpful. All are available upon written request from Technical Information Center, Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Arizona 85036. References 2 and 3 are contained in Motorola's "The Microelectronics Data Book," second edition, December 1969.

### references

1. Motorola Application Note AN-457, "Switching Voltage Regulator Uses Discrete and Integrated-Circuit Approaches."
2. Motorola Application Note AN-473, "A Monolithic High-Power Series Voltage Regulator."
3. Motorola Application Note AN-480, "Regulators Using Operational Amplifiers."

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100	.06	.08	.16	.20
200	.08	.10	.20	.25
400	.12	.14	.28	.50
600	.14	.16	.32	.58
800		.20	.40	.65
1000		.24	.48	.75


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# conversion from fast-scan to slow-scan television

Scan conversion  
offers an easy way  
to get on sstv —  
here are some ideas  
for sampling circuits  
and a  
multimode camera

**Slow-scan television (sstv)** has been called one of the new and exciting frontiers of amateur radio, and rightly so. The number of experimentally inclined amateurs regularly transmitting and receiving good-quality still pictures with standard ssb equipment is steadily increasing. Listen on 14.23, 7.22, or 3.845 MHz, especially late in the evening, and at International sstv net time (2 p. m. EST) on 14.23 MHz to verify this for yourself.

First, however, you'll need an sstv monitor. Many construction articles on monitors have been published. One of the most recent describes an oscilloscope adapter for decoding sstv signals.<sup>1</sup>

What is needed to attract more amateur tv enthusiasts into the realm of sstv — for example, those now active on fast-scan atv in the 450-MHz band — is an easy way to use homemade or manufactured vidicon cameras on sstv.

For about a year we have been developing a simplified approach to scan conversion in addition to perfecting solid-state monitors. Don Miller, W9NTP; Ted Cohen, W4UMF; and others have pioneered with sampler cameras that convert fast-scan (FS) or standard tv signals to slow-scan (SS) standards (see reference 2).

W3EFG has built a multimode camera that includes a sampler board. It has performed well on the air and was first shown and demonstrated at the 197C Dayton Hamvention. W3YZC started with a homebrew fast-scan vidicon camera and built a separate scan converter with power supply. This unit used the camera video output to derive sstv signals.

## modifications for sstv

The circuits described in this article to obtain sstv signals can be easily adapted to almost any tube or transistor vidicon camera without destroying the capability of the camera for use elsewhere. The only change necessary in the camera is the addition of simple transistor circuitry to provide a switchable 15- or 60-Hz frame rate from the vidicon camera. This consists of adding a 4:1 unijunction-transistor countdown circuit to convert the 60-Hz pulse to 15 Hz and the addition of a larger value vertical-sweep capacitor. The circuit includes 3 transistors, a few resistors and capacitors, and a miniature dpdt toggle switch

\*Co-author W3YZC joined the silent keys in January. Al's passing is a great loss to all who knew him.

R. F. Stone, W3EFG and A. B. Schechner, W3YZC

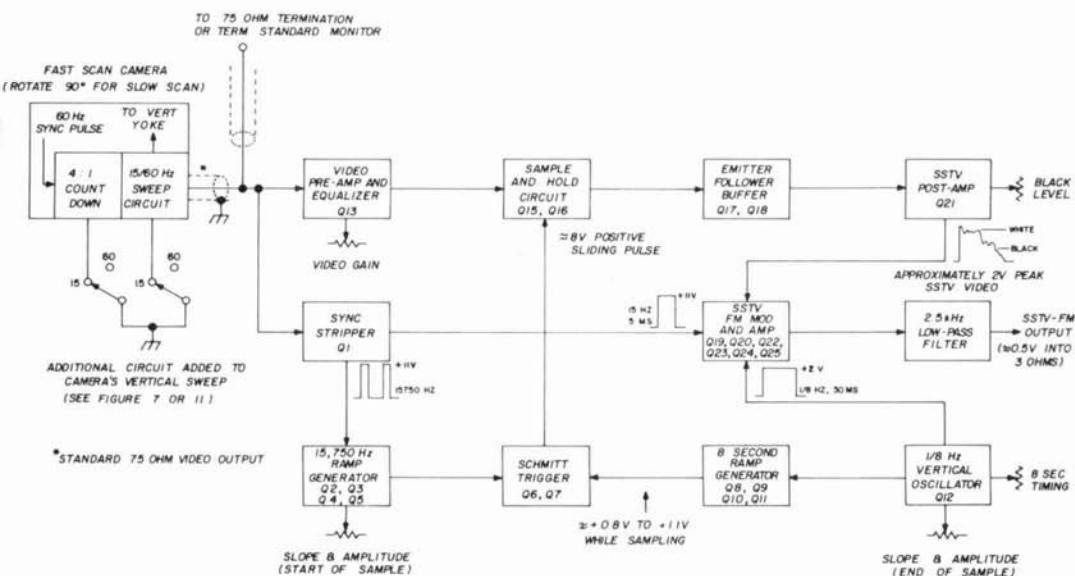


fig. 1. Block diagram of the FS-to-SS converter.

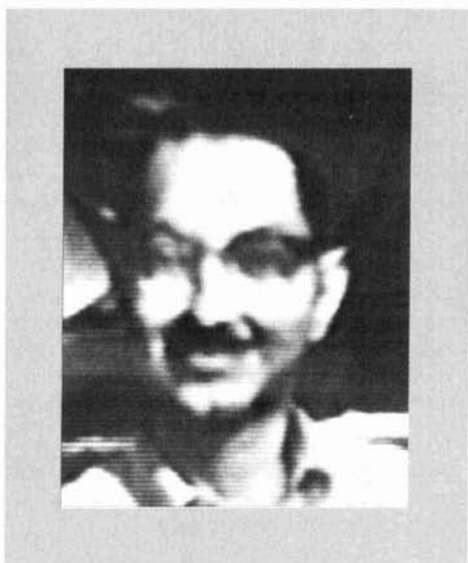
mounted on the back of the camera.

The composite video signal is used "as is" — the horizontal (15,750 Hz) and vertical (15 Hz) sync signals are stripped in the scan-conversion circuit. For slow scan, the modified FS camera must be tilted 90 degrees and operated on its left

side, so that what was originally the top of the picture will be to the viewer's right. It's not necessary to reverse the vertical yoke connections because of the polarities used in producing the sliding pulse from the 15,750- and 1/8-Hz ramps (see reference 2).



Co-authors W3EFG . . .



and the late W3YZC via slow-scan tv.

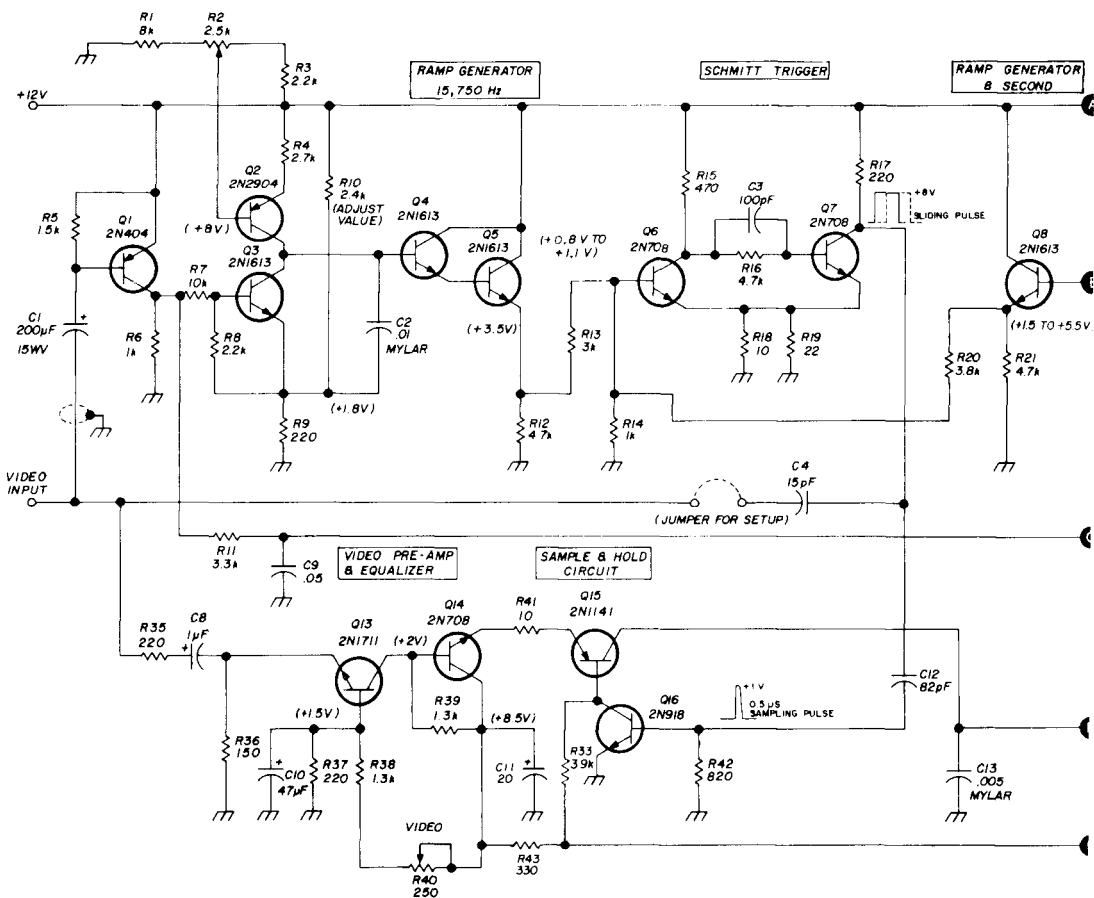


Fig. 2. Schematic of the slow-scan converter. Voltages and waveforms are shown for initial setup.

## features

The scan converter design uses a minimum of components. Proven, debugged circuitry results in a scan converter that delivers a high-quality sstv picture with excellent resolution and contrast. The converter is easy to build and adjust. The accompanying photos, taken with the circuitry described here, pretty well speak for themselves.

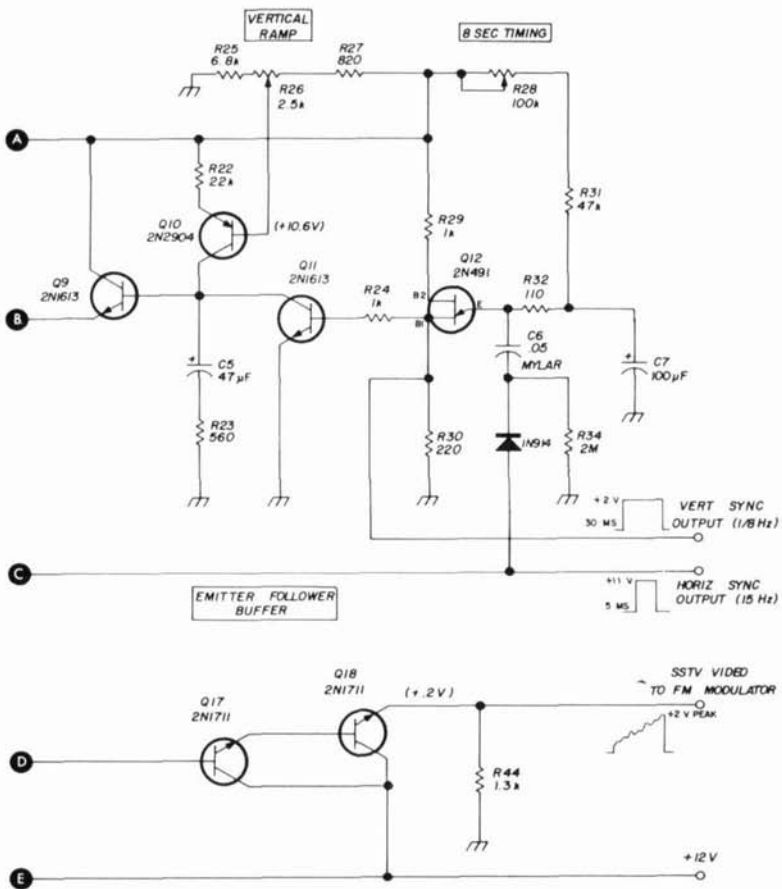
The following paragraphs described the basic scan converter circuits and give some ideas for packaging. We have also included a brief description of the multimode vidicon camera built by W3EFG, A printed-circuit board and parts kit for the scan converter is available from HAL Devices, Box 365H, Urbana, Illinois 61801.

which includes design innovations from circuits by W3YZC and from the articles on homebrew cameras<sup>3, 4</sup>.

The multimode camera was the result of an attempt to build a densely packaged, universal camera later used on atv, sstv and that could be adapted for experimentation on vhf and uhf with pseudo-random narrow-band tv having motion capability.<sup>5</sup>

## converter functional description

The functions of the scan converter are depicted in fig. 1, which shows interconnections for a standard vidicon camera. The 4:1 countdown from 60 to 15 Hz and the sweep-circuit modification will vary somewhat from camera to



camera. However, circuit details associated with a typical modification may be deduced from the vertical-sweep circuit of the multimode camera described later (see fig. 7).

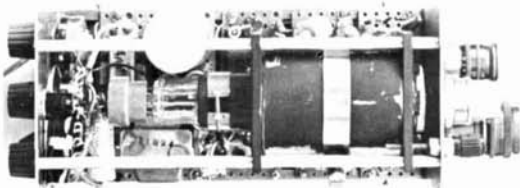
The block diagram shows the various set-up and operational potentiometers as well as typical waveforms and voltage levels. If positive-going horizontal and vertical sync pulses are available in the camera, sync stripper Q1 may be eliminated. This was done in W3EFG's camera, since the FS board was directly beneath the SS converter and fm modulator board.

### scan circuit

The scan converter schematic is shown in fig. 2. Composite standard video is fed to both the sync stripper, Q1, and to the video preamp and equalizer, Q13. The

15,750-Hz pulses initiate a linear 15,750-Hz sawtooth voltage that is added to a 1/8-Hz linear sawtooth voltage from an 8-second vertical oscillator, Q12. Note that Q12 is a free-running oscillator, which is synchronized with the start of the sstv horizontal line by the network

### W3YZC's homebrew FS vidicon camera.



composed of 1N914 diode, R34, and C6.

The two ramps are added across R14 of the Schmitt trigger, which causes the circuit to fire over the range of approxi-

R35, C8, R36. The time constant of C8, R36 was chosen to attenuate the lower frequencies of the fast-scan video. We found this to be necessary with most vidicon cameras, because the vertical

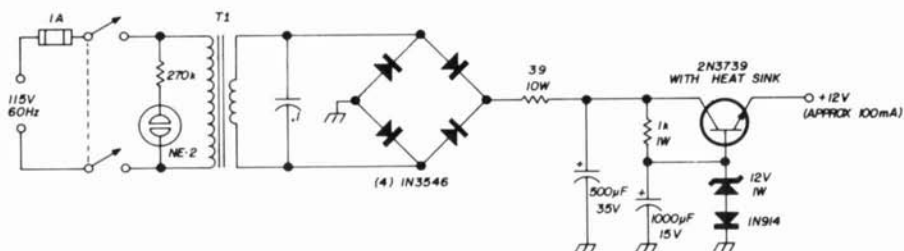


fig. 3. Suggested power supply for the sampling converter and fm modulator. T1 is a 24-26 volt, 1 amp filament transformer (Stancor P6469, Lafayette 99E62663, or equivalent).

mately 0.8 to 1.1 volt. This produces a sliding pulse at the collector of Q7 that is differentiated by C12 and R42 to give a  $0.5\text{-}\mu\text{s}$  pulse (approximately). The  $0.5\text{-}\mu\text{s}$  pulse opens gate Q16, which samples the video through Q15 to holding capacitor C13. The charge on C13, which is the sstv sampled video, is coupled by a Darlington-pair buffer, Q17, Q18, to the modulator.

The value of holding capacitor C13 was optimized to produce the best sstv picture. Emitter followers Q17, Q18 provide a high-impedance source to the collector of Q15.

A common-base-connected video pre-amp, Q13, drives the sample-and-hold circuit. The incoming standard FS video is fed through an equalizing network,

shading showed up as a bright or dark area on the left or right side of the sstv picture.

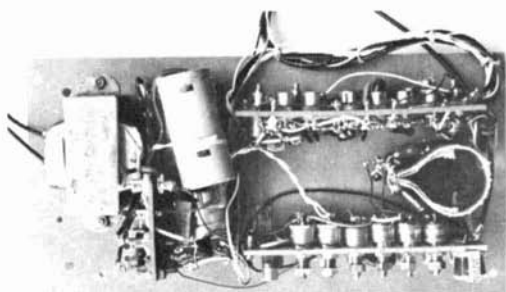
The video pot, R40, adjusts the bias of Q13 and controls both gain and the sync clipping level. The gain of Q13 is approximately equal to the ratio of R39 to R36 and may be adjusted if required.

### device selection

Special mention should be made about the characteristics of the sampling-gate transistor, Q15. Considerable investigation preceded the selection of the optimum device to produce the best resolution consistent with good gating action.

A transistor with poor gating characteristics will produce a leak-through pattern on the sstv monitor, resulting in streaks as the picture is painted across the tube. Best operation was obtained from a high-speed germanium switching transistor — the 2N1141. The 2N1141 has been around for quite awhile and is still listed in the catalogs. A lower-frequency 2N1142 was tried, but it produced slightly degraded performance.

All transistors shown in the schematics have worked well. Countless other npn and pnp devices with similar or related characteristics are available and may be used in these circuits. For example, the inexpensive epoxy transistors have been used in most circuits and work fine. The

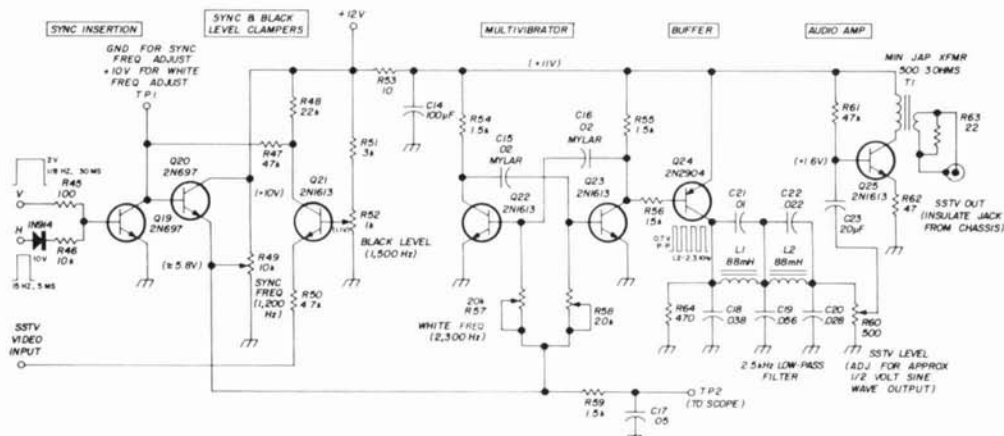


Slow-scan converter and power supply used with W3YZC's camera.

2N3906 will probably replace the 2N2904, and the 2N3904 will likely work in place of the 2N1613 or the 2N697.\* We suggest that if you wish to use junk-box transistors, stick with the silicon types,

## slow-scan modulator

An sstv fm modulator similar to that used by most slow scanners is shown in **fig. 3**. Its setup on frequency is straightforward and has been previously de-



**fig. 4.** Modulator schematic for FS-to-SS converter.

with the exception of the 2N1141 for Q15.

## power supply

The sampling system is totally intolerant of 60- or 120-Hz hum in the video. Even a few hundredths of a volt ripple will show up as vertical bright bars, slight undulations, or wavy kinks on the horizontal sweep in the sstv picture. For this reason it's essential that the power supply be well filtered, with less than 0.01-volt ripple or better. The circuit of **fig. 4** is recommended for the scan converter and modulator.

In some vidicon cameras, stray magnetic fields may occur at a 15-Hz frame rate. Thus it may be necessary to disconnect the primary of a self-contained power transformer. Filament and vidicon voltages can then be supplied from an external supply placed at least three feet from the camera. Only operating experience will reveal this requirement.

\*See Motorola's "Semiconductor Data Book," 5th edition, October 1970, for recommended replacements and substitutions for these devices. editor.

scribed.<sup>2</sup> Voltages and input waveforms are shown in **fig. 1**. It is desirable to first apply 10 volts to T. P. 1 and set the 2300-Hz white frequency, then ground T. P. 1 for the 1200-Hz sync frequency from the multivibrator. This should be



Identification chart used by W3EFG.

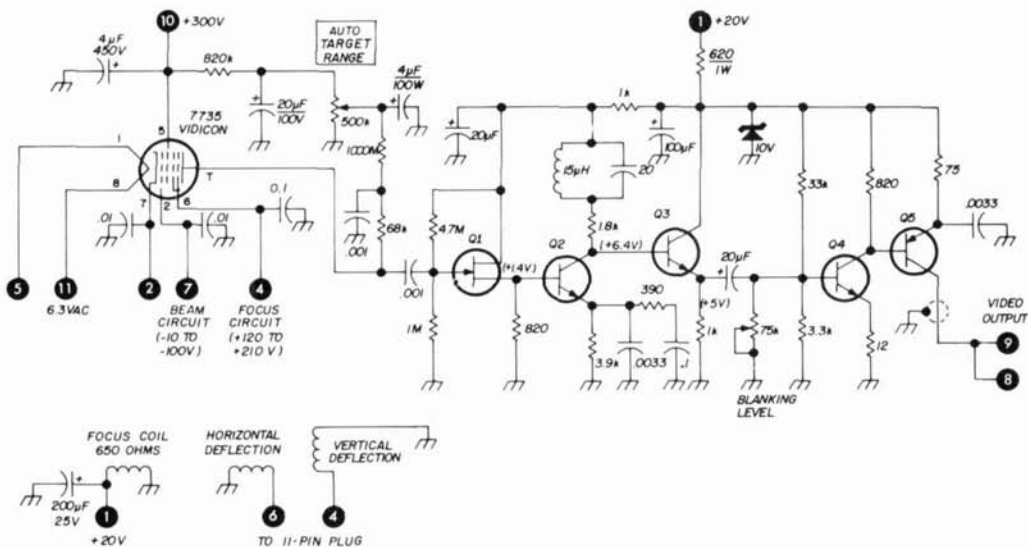


fig. 5. Multimode vidicon camera head with video amplifier.

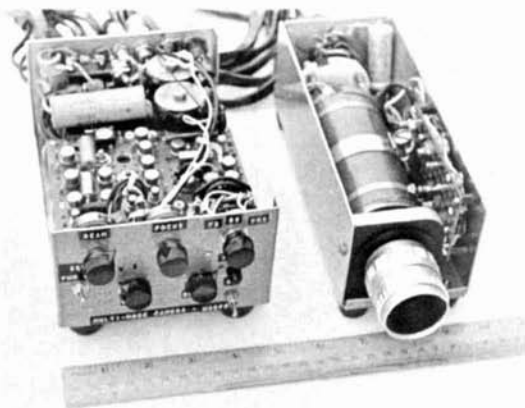
repeated several times. T. P. 2 (filtered by R59 and C17) is a good point to connect an oscilloscope for monitoring black and white level in the scene being televised. Using the lens iris and video pot R40, adjustments should be optimized to prevent white clipping and to obtain proper black-level excursion.

Following the multivibrator, Q24 provides drive to the 2.5-k Hz low-pass filter. L1 and L2 are 88 mH toroids, tuned by the capacitor values shown. The odd

values should be obtained by combining standard-value mylar or mica capacitors.

The filter may be mounted on a small board that can be tucked into an available space, along with the power supply. Note that sstv output is at a low impedance and at a fairly high level (approximately 0.5 volt across 3 ohms), which is compatible with 3-8 ohm outputs from receivers and recorders. The sstv output is taken from a phono jack insulated from the case with fiber washers.

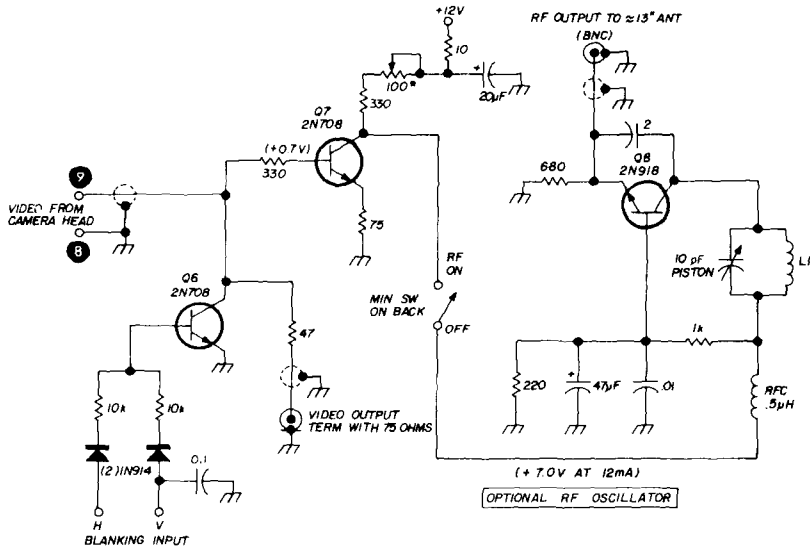
#### Multimode vidicon camera built by W3EFG.



#### set up procedures

It is convenient to view the FS video on a fstv video monitor when setting up the start of the sampling pulse and the point on the horizontal ramp where the pulse ends and returns to start a new sstv frame. Since Q13 tends to isolate feed-through of this pulse to the video input, C4 should be jumpered to the video input, for initial setup. The differentiated spike will then be clearly visible on a regular monitor as a thin, bright vertical line. Its width is indicative of the sampling-pulse width, and its excursion from the viewer's right on the screen to the viewer's left indicates that portion of the FS picture being sampled.





\*ADJUST FOR OPTIMUM SYNC LEVEL ON RF SIGNAL  
 L1 = 3-1/2 TURNS NO. 16, 1/4" 10, TUNES CH 7-13 WITH 10pF PISTON CAPACITOR

fig. 6. Video blanking mixer and video-modulated rf oscillator for the multimode vidicon camera.

A 1:1 aspect ratio is used in sstv, so a narrow portion to the left and right of the FS picture will be lost. Since there is some interaction in adjustments, a careful procedure must be followed to center the sampling range while watching the FS monitor. (Two small pieces of black tape on the monitor screen will help.)

The horizontal-ramp pot, R2, will affect the beginning of the sampling pulse.

The sampling speed, and hence the limit or end of a frame is determined by the vertical-ramp pot, R26. Resistor R10 sets a dc level of 1.8 volts, which may be adjusted to shift the sampling-position range of R2 and R26.

A vernier range of adjustments is possible for R2 and R26; however, the final setting of both controls is quite critical. Screwdriver-adjusted potentiometers

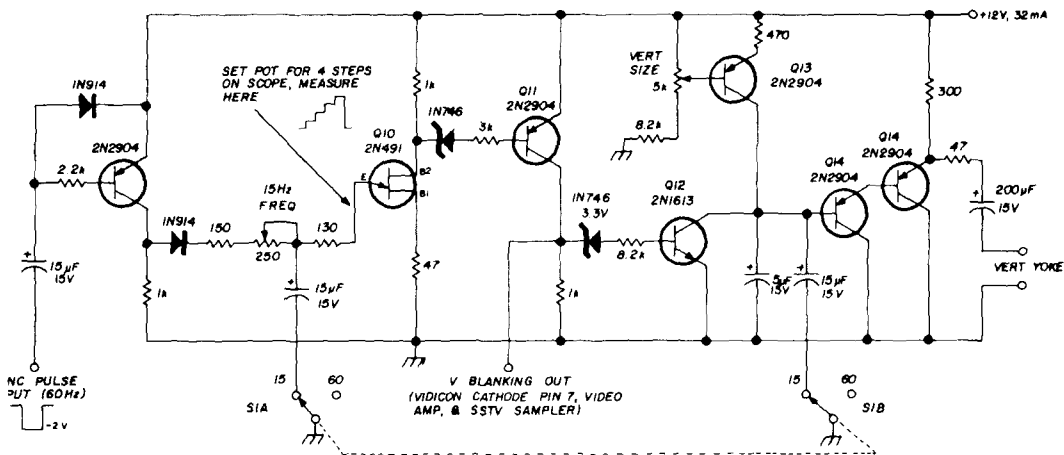


fig. 7. Vertical-sweep circuit for FS or SS camera.

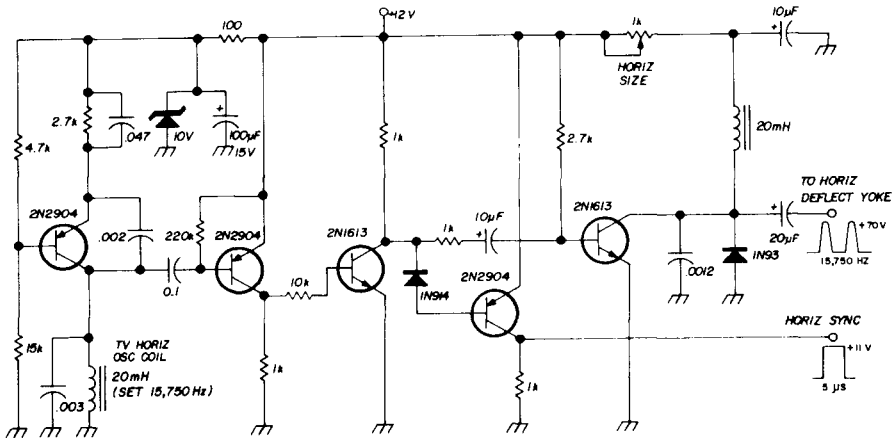


fig. 8. Horizontal-sweep circuit for FS or SS camera.

meters with locking nuts are recommended.

The voltages and waveforms shown in fig. 2 are provided as a guide. These are approximately equivalent to those obtained by the authors. Patience during adjustment and optimization of values may be required.

### packaging

The converter shown in the photo is

contained in a 10 x 5 x 3-inch minibox which provides ample room for two small power transformers and associated switches, pots, and connectors.

The vector-board chassis could be adapted to a printed-circuit board. Perhaps some enterprising slow-scan enthusiast with PC-board layout facilities will tackle this job and make such boards available. This would certainly give sstv

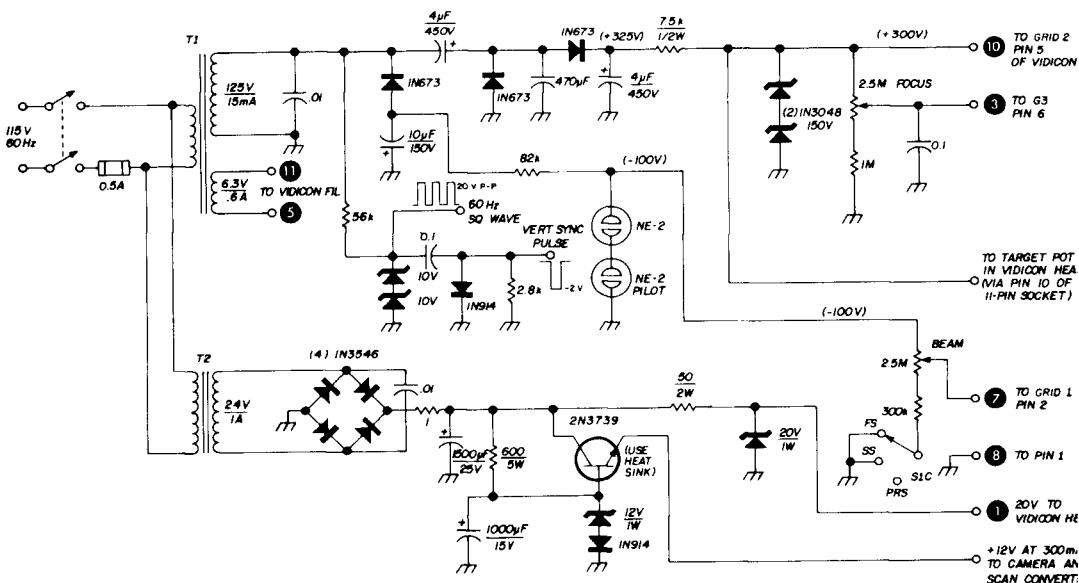


fig. 9. Suggested power supply for FS or SS camera. T1, Lafayette 33E34059; T2, Lafayette 99E62663.

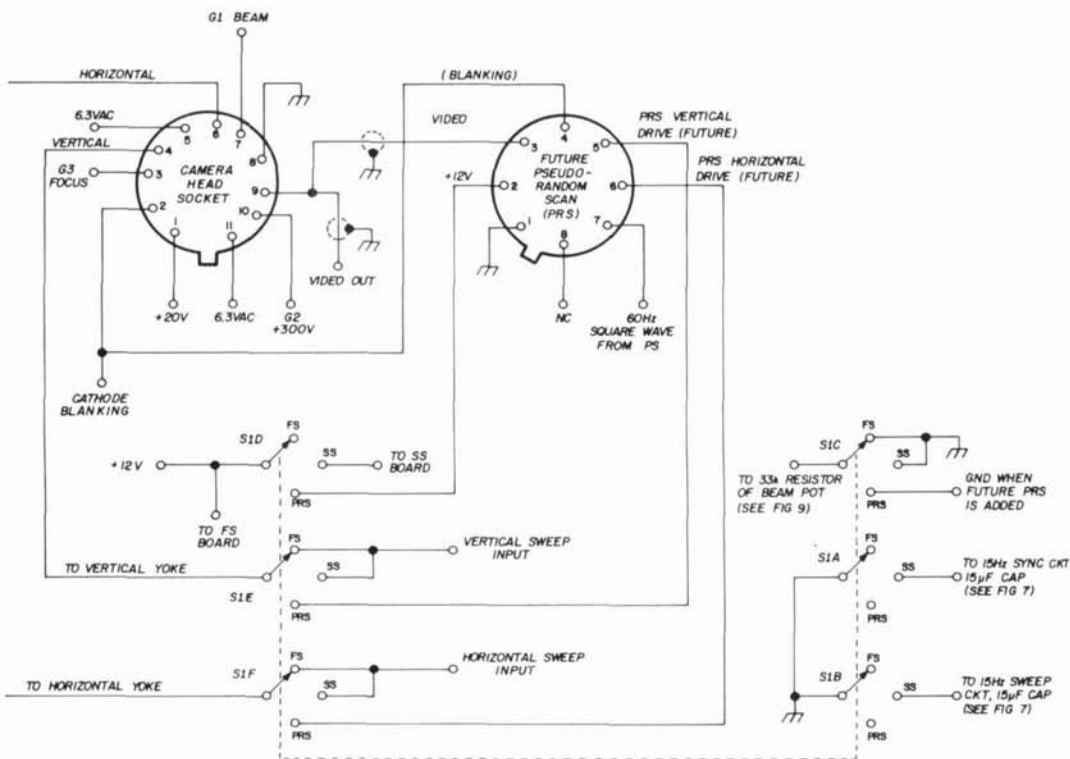


fig. 10. FS/SS/PRS switching circuit for the multimode camera.

activity a further boost with more sampler cameras on the air.

Scan converter board wiring is not critical as to lead lengths, interconnections, or placement of wires and components. Standard construction techniques were used. Push-through vector board pins were used for tie points. Resistors and capacitors were wired point-to-point to the transistor sockets. Several straight buswire runs on pins for the 12 V and ground leads were used. Because of the high frequency components in the narrow sampling-pulse circuitry, single-point ground returns for Q6, Q7, Q16, and Q15 are recommended. Also a short run of 75-ohm mini-coax from the back panel video connector to the video input is essential, plus a short length of coax across the board to C1 of the sync stripper transistor, Q1. These coax cables should be grounded at only one point on the board to prevent ground currents in the FS video.

## fast-scan camera

The circuit details shown in figs. 5 through 10 are provided with a minimum of explanation for those ambitious slow-scanners who may wish to duplicate a



Solid-state sstv monitor using a 5FP7 tube. The photos of the ID chart and the authors were made from W3EFG's camera and this unit.

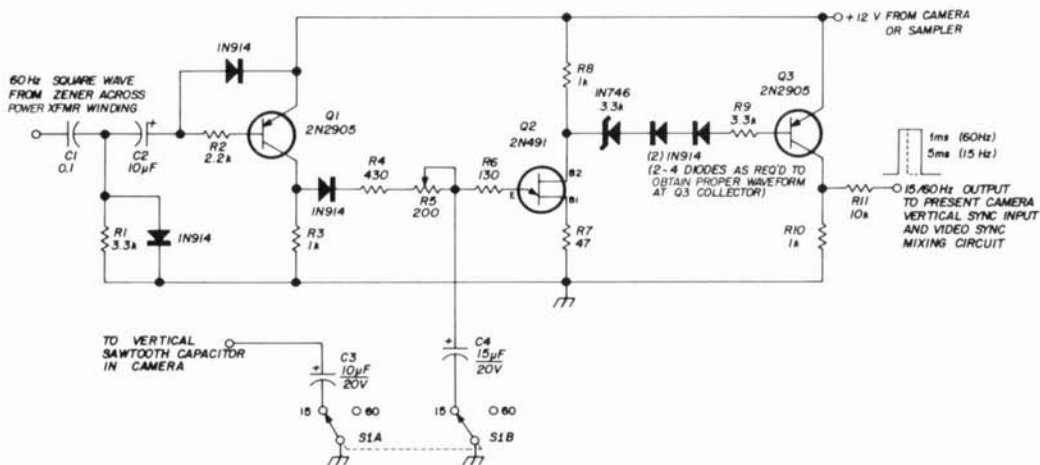


fig. 11. 15/60-Hz vertical sweep modification for a standard vidicon camera for use on sstv. C1, R1, C2, R2 determine the 60-Hz pulse width. The sstv 15-Hz sync pulse width is determined by R6.

typical homebrew multimode camera. These circuits, which are used in W3EFG's camera, are generally straightforward and can be modified to drive vidicon focus-deflection-coil yoke assemblies having different impedances.

With the exception of the video board

and vidicon yoke in the 3 x 2-1/2 x 8-inch camera head, all circuitry in figs. 6 through 8 are on a vector board measuring 4-5/8 x 3-11/16 x 3/32 inches. This FS board is mounted in the 5 x 7 x 3-inch minibox beneath the SS converter board. Switching is shown in fig. 10 for the various operating modes.

A suggested power supply for the entire camera is shown in fig. 9. Only the portion of the supply associated with the 24-volt transformer need be built if only the scan-converter board is constructed. However, the supply can be built to supply total power to an existing camera if hum problems develop, as mentioned earlier.

## vertical sweep

Attention is called to fig. 7, which shows the vertical-sweep circuit. To make the 15 to 60 Hz frame-frequency modification to an existing camera, as mentioned earlier and shown in fig. 1, parts of the circuit in fig. 5 can be used. We suggest that the components associated with Q9, Q10, Q11 be put on a small vector board, with the indicated switching circuit (see fig. 11). This board may then be placed in any available space within, or external to, an existing camera. Careful study of the particular camera circuit will show the correct tie-in points.



Another "seeing aid" used by W3EFG. Monitor features solid-state circuitry built into an old Waterman scope case. It provides a 1-1/4-inch-square image, which is magnified to 2 x 2 inches with a lens attachment. Inquiries from serious hams on this and the other equipment described are welcome. Send your questions and comments, together with a self-addressed stamped envelope, to W3EFG, 506 Eastwood Drive, Exton, Pennsylvania 19341.

This modification should work equally well with random interlace and 2:1 interlaced cameras.\*

## conclusion

These fast-scan camera circuits are third- and fourth-generation versions used by the authors. All are proven circuits and produce excellent FS and SS pictures.

This article is intended to provide active slow-scanners and offers an optimum means of producing high-quality, live sstv pictures. You may wonder if "holding still" for eight seconds is difficult. Our experience shows this is no problem. Since we're scan-converting or sampling a fast-scan camera, there is no latent change pattern on the target, such as may occur with the open-shuttered vidicons usually employed in the SS mode.

Other advantages of the sampling approach include the ability, in real time, to focus the vidicon optically and electrically. Second-order benefits include automatic light compensation via automatic target circuitry.

We would like to thank all sstv amateurs contacted for their continued interest in our activities and for their encouragement. In particular, thanks are due W9NTP and W4UMF for their inspiration and pioneering efforts to promote the sampling technique, which appears to be a much-needed break-through for sstv amateurs.

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5. Sid Deutsch and R. Simpson, WA2PAX, "A Continuous Motion Narrow Band Television System," *CQ*, April, May, December, 1968.

\*A G. E. 4TE23 camera was so modified with excellent results.

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antenna coupler  
for 50 MHz  
matches both balanced  
and unbalanced feedlines  
and uses  
commercially-available  
hardware

Current six-meter transceiver and transverter designs follow the general supposition that the operator will be using 50-ohm coaxial cable and an antenna system of like impedance. Output tank circuits are usually pi-networks designed to match a 40- to 60-ohm load and allow little deviation beyond these limits. On the other hand, the amateur buys 50-ohm coax, assembles a 50-ohm antenna to the manufacturer's specifications, and assumes the load presented to the output of the transceiver is 50 ohms. In most cases it is not unless careful attention is given to swr measurements, antenna match

adjustments, antenna location and a host of other variables.

To compound the problem amateurs begin loading the system with goodies such as swr bridges, monitor scopes and the like which do nothing to improve transmission line flatness, and in most cases add to the mismatched condition by adding impedance "bumps" to which the transceiver has difficulty accommodating. The end result is a transceiver which is difficult to tune and erratic to operate.

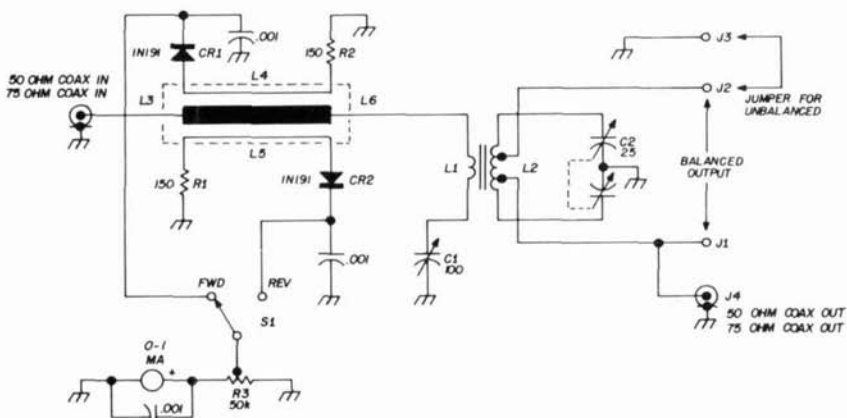
In these situations the often maligned and usually misunderstood antenna coupler can be used to its best advantage. Many hams who lack experience with couplers have the mistaken idea that they are a panacea solution to antenna problems. However, an antenna coupler will *not* compensate for a misadjusted antenna or one in need of repair; nor will it compensate for final-tank-circuit inefficiencies.

It *will* provide the transmitter with a constant load impedance irrespective of antenna variations. In addition, it will assist in receiving by attenuating spurious signals through the introduction of another tuned circuit in the input.

### construction

Many articles have been written on antenna couplers. Unfortunately, these designs often require the builder to fabricate coaxial cavities and various plastic

Louis E. Savoie, K1RAK, 29 Hillsdale Road, Holbrook, Massachusetts 02343



- |    |  |            |   |
|----|--|------------|---|
| C1 | 25 = pF butterfly capacitor (E. F. Johnson 167-22)   | L4, L5     | 0.062 brass rod, 4" long (Heathkit 40-99)           |
| C2 | 100 pF variable (Hammarlund HF-100)  | L6         | coaxial section (Heathkit 40-100)                   |
| L1 | 2 turns no. 14 enameled, 2-1/8" diameter, over center of L2                                | J1, J2, J3 | 5-way binding post                                  |
| L2 | 7 turns no. 10 spaced 1/2 wire diameter, 1 1/2" diameter, tapped 2 1/2 turns from each end | R3         | 50k pot, linear taper (Heathkit 10-11)              |
| L3 | 0.250 brass rod, 5" long (Heathkit 40-98)  | S1         | spdt toggle or 2-position rotary (Heath-kit 63-177) |

SWR bridge uses coaxial line section from Heathkit bridge.

spacers and other hardware to incorporate an swr bridge into the coupler. The coupler described here takes the lazy man's approach and uses commercially-made hardware throughout; it requires an absolute minimum of fabrication.

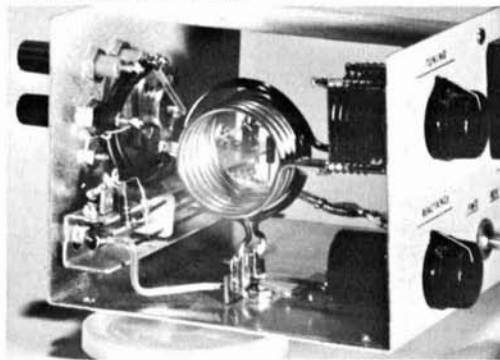
The coupler consists of a conventional input/output circuit of a 2-turn input coil

tuned with a 100-pF variable to ground. The input coil surrounds the output coil and is inductively coupled; the output inductor consists of 7 turns of no. 10 copper wire tuned by a 7-35 pF butterfly variable to ground. The output inductor is tapped for 300-ohm balanced output at 2 1/2 turns from each end.

### swr bridge

An swr bridge is included to provide a self-contained functional unit. The heart of the bridge consists of a coaxial cavity line and rf pickoff elements from a Heathkit swr bridge. The coaxial-section components were purchased from Heath for less than \$2 and eliminated the need for sheet-metal bending, parts fabrication and chasing all over for plastic, brass rod and the like. The meter is a Radio Shack Micronta, 0-1 mA, catalog no. 22-018. The meter face was removed, and the original numbers and lettering were

SWR bridge circuitry is mounted on rear panel of chassis.



erased with a coarse typewriter eraser. The scale was relabeled to correspond with *swr*. Lettering was done with rub-on letters. The meter face was then sprayed with clear acrylic. A full-scale drawing of the meter face is shown in **fig. 1**.

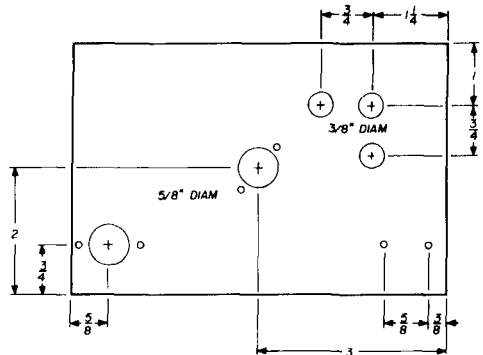
### assembly

Drilling templates are shown in **figs. 2** and **3**. The chassis should be drilled and all holes deburred. Burnish all exterior surfaces with 00 or 0 grade steel wool. Wipe all surfaces to be painted with a degreasing solvent or white vinegar to remove surface dirt and oils. The unit in the photograph was built for K1ZFE and was painted flat black and Dove Gray to match his equipment. Krylon spray colors were used; excellent results were obtained by applying several light coats with plenty of drying time in between. After painting, each cabinet half was baked in an oven for one hour at 200° to assure complete drying. Black transfer lettering was added to the front panel and Dymo labels on the rear.

Mechanical assembly should begin with the *swr* coaxial section and SO-239 input connector. The section must be shortened by one inch to fit this cabinet. The output end of the coax section center conductor is mounted to a 6-32 ceramic standoff insulator. Then add the terminal strips, terminating resistors,

rectifier diodes and .001 bypass capacitors; assemble the switch, sensitivity pot and all interconnecting wiring. Wiring from the rectifier diodes to the switch should use shielded wire.

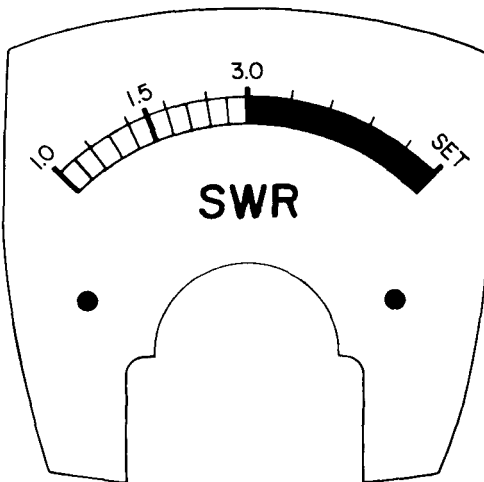
The two front-panel air-variable capacitors and the terminal tie point on the left side (bottom) of the chassis should be assembled to the cabinet next.



**fig. 2.** Rear-panel layout for the coupler.

Tie the ground lugs of each air variable together and to the center ground terminal of the tiepoint; use no. 14 copper wire. L2 is connected to the butterfly capacitor by two copper sleeves made by enlarging the diameter of a 1/2-inch long piece of 3/16-inch copper tubing. Use a 100- or 150-watt soldering iron for soldering.

**fig. 1.** New meter face for Micronta meter.



**table 1.** Parts list for 6-meter antenna coupler.

qty	description	cost
1	Chassis Box (LMB 564 N)	\$2.95
1	Meter (Radio Shack 22-018)	2.95
1	Butterfly variable (E. F. Johnson 167-22)	3.45
1	Hammerlund variable (HF-100)	2.65
1	Coaxial section (Heath 40-100)	.20
1	Rf driver element (Heath 40-98)	.55
2	Rf pickup element (Heath 40-99)	.20
3	Plastic spacer (Heath 255-12)	.30
3	2-lug terminal strip (Heath 431-14)	.30
2	SO-239 coax connectors	1.70
1	50k pot (Heath 10-11)	.50
1	2-position rotary switch (Heath 63-177)	.85
2	1N191 Diodes	.60
2	.001 disc capacitors	.40
2	150 ohm resistors, 1/2 watt	.20
1	Ceramic standoff	.45
3	Binding posts (Superior)	.90



Be sure to slide L1 over L2 prior to completing the assembly of L2 to the butterfly. Bend the legs of L1 to fit the spacing of the two ungrounded tie points and make sure that the spacing of L1 around L2 is even. Connect the output of the coaxial line to one end of L1; connect the other end of L1 to the stator of the 100-pF variable.

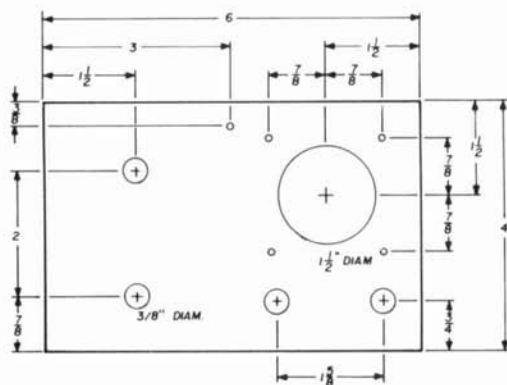


fig. 3. Front-panel layout for the coupler.

Assemble the 5-way binding posts to the chassis and the output coaxial connector to its mounting hole. Connect the upper two binding posts to the taps on L2 with a short piece of 300-ohm transmission line (preferably foam filled). Connect the output coax connector to the 5-way binding post nearest the center of the chassis. The lower binding post nearest the outside edge of the chassis should be connected to ground. Assemble the meter to the cabinet and wire it to the 50k pot. All interconnecting wiring in the L1/L2, C1/C2 section is done with no. 14 wire.

### test and operation

If the coupler is to be used from one coaxial cable to another, install a jumper wire between the grounded binding post and the one directly above it. This *must* be done to use the coupler for coax-to-coax transfer. Connect the coupler between the transmitter and the antenna or a 50-ohm non-reactive dummy load such as the Heath-kit antenna. Tune the transmitter for low power output. Set the

swr bridge switch to forward and adjust the sensitivity pot for full meter deflection. Reset the switch to reverse and adjust C1 and C2 for minimum reflected power. It should be possible to adjust the reflected power to zero.

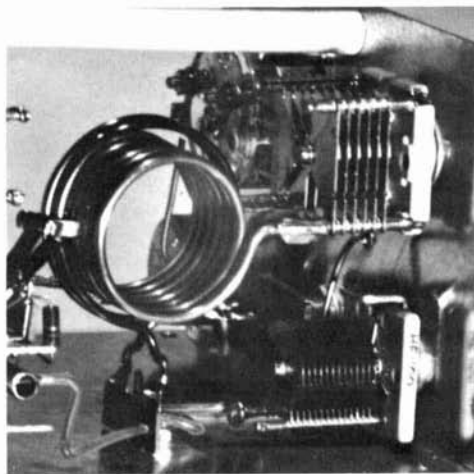
When the coupler is adjusted for minimum reflected power the transmitter can be tuned for full output power. It is possible to move 100 kHz either side of the tuned frequency before the coupler must be re-adjusted. Once the antenna coupler is set for minimum reflected power, leave it alone — tune the transmitter final to obtain maximum output, not the coupler.

### conclusion

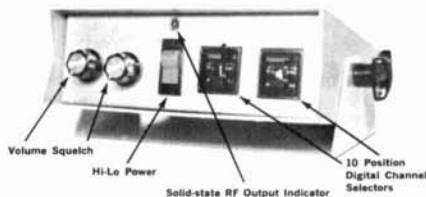
This unit will handle up to 500 watts without problem. Insertion loss has been measured at 1 to 2 percent. However, the improved efficiency provided by the coupler more than compensates for the low insertion loss. For those amateurs who already have an swr bridge, the coupler section could be built into a smaller cabinet and used with the existing bridge. Tuning procedures would be the same. Just be sure to install the swr bridge between transmitter output and the coupler input.

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Inside view of antenna coupler shows mounting of L1 and L2.



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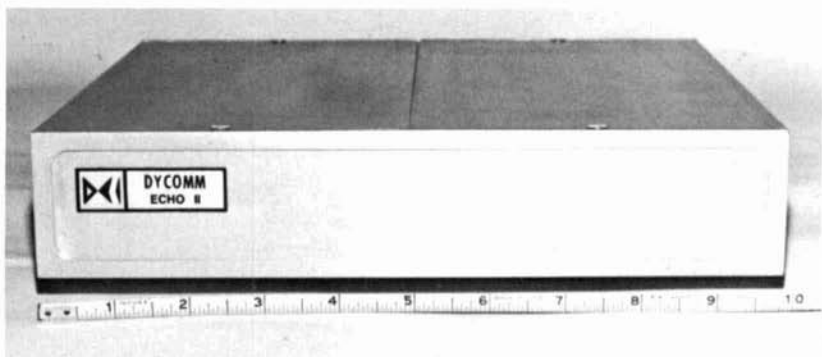


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# versatile vox

## Solid-state circuit for voice-operated transmission and fast cw break-in

Presented in this article is a solid-state vox unit designed as a companion to my 9-MHz ssb generator described in an earlier issue of *ham radio*.<sup>1</sup> I had three objectives in this design:

1. Operation with all normal settings of the ssb generator audio-gain control and with all settings of the hang-time control.
2. Operation in the cw mode, with a minimum of components, and with fast pick-up time to avoid lost characters.
3. Fast break-in operation.

### circuit description

The circuit that fulfills these requirements appears in **fig. 1**. The function switch is shown in the ssb vox position. The vox input from the generator feeds the base of Q1 through CR1. Note that a

positive input is required. To provide this, the ssb generator should be modified as shown in **fig. 2**. The 47k resistor is connected to ground to quickly discharge the vox filter capacitor.

With no vox input, Q1 has no drive; consequently Q2 and Q3 are turned off. When a positive input arrives from the generator, Q1 turns on Q2, which in turn drives Q3 into saturation, causing relays K1 and K2 to operate. One contact of K1 grounds the transmitter keyline and opens the mute line to the receiver. The second contact may be used to close relays in a linear amplifier when the vox relays close. The hang time is primarily determined by the C3, R4 time constant. The value of R4 was selected so that several times more current would flow through it as into the base of Q2. This minimizes the effect of Q2's base current on the hang time and consequently minimizes temperature effects on the hang time due to transistor gain variations.

The network of CR2, CR3 and R6 insures proper operation of the vox circuit at very short hang time settings. Without these components, C3 must charge and discharge through a major portion of R4's resistance. This means that if the hang-time control is set for a half second as an example, several dots or dashes of a letter must be sent before the vox relays will hold in. With the network shown, C3 charges rapidly to nearly the emitter voltage of Q2 through R6 and CR3 upon closing the key. Upon releasing the key, Q2 receives base drive through CR2, thus avoiding the high attenuation

Richard Bain, W9KIT, 4915 Ridgedale, Fort Wayne, Indiana 46815

path through R4. The quick-charge network also helps prevent relay chattering with short hang-time settings in the ssb vox mode. At the maximum hang-time setting, CR2 is shorted out and CR3 is back-biased with the key down, so neither affects circuit operation. CR3 is also back-biased when the key is released regardless of the hang-time setting and

megohm, and so should not disturb the bias circuits of most transmitters. The voltage at my key is -35 volts. For higher keyline voltages, increase the size of R3, and reduce it for lower voltages.

### cathode keying

You may have a cathode-keyed transmitter with which you may wish to use

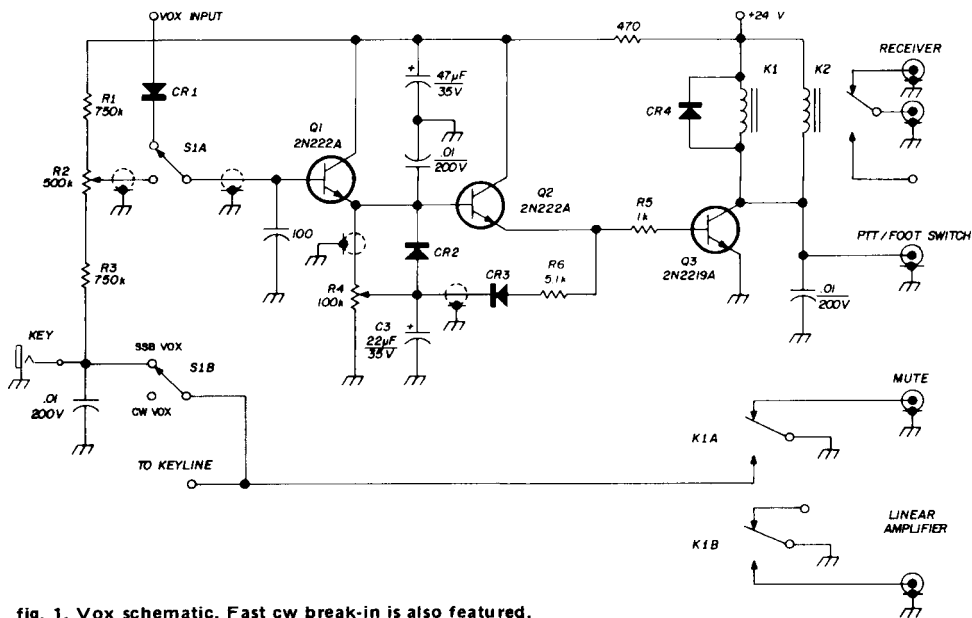


fig. 1. Vox schematic. Fast cw break-in is also featured.

thus has no effect on the discharge curve of the hang-time network.

The 1k resistor in series with the base of Q3 limits the base current to safe values, in this case about 8 mA maximum. The diode across the relay coils clips the large voltage spike created when Q3 turns off in a short time period, such as during break-in operation.

In the cw vox position of the function switch, the keyline is connected to the key jack. Resistors R1, R2 and R3 form a summing network between the positive vox supply and the negative keyline voltage. R2 is adjusted so that the voltage at the base of Q1 is zero. The resistance presented to the keyline is close to a

this circuit. In that case, Q1 may be changed to a pnp transistor and components added to the transmitter as shown in fig. 3. The voltage of the zener diode must be larger than the vox circuit supply voltage and must also be large enough to completely cut off the final tubes. The values of R1, R2, and R3 must be large enough to hold Q1 base current to a safe value. Values as shown in fig. 1 are satisfactory. R2 is adjusted so that Q1 base voltage just equals the emitter voltage. Note that the vox input now comes into the base of Q2. This means that a lower-impedance source of this vox voltage is desirable for rapid charging of the hang-time network. The R-ZD1 combina-

tion could be replaced by a voltage divider if regulated voltage is available in the transmitter.

### break-in

Break-in operation in the cw vox position is possible by turning the hang-time control to minimum. The two relays (if they are capable) will now follow the key. For break-in operation up to several

### device considerations

The transistors are on the expensive side, but satisfactory substitutes can be found. As an example, Poly Paks lists the 2N2222 at five for a dollar. While their  $V_{CE}$  is 30 Vdc, they should work well if care is taken to hold the supply voltage to 24 Vdc or less. The power dissipation of Q1 and Q2 is negligible, but that of Q3 depends on the relay current required. As

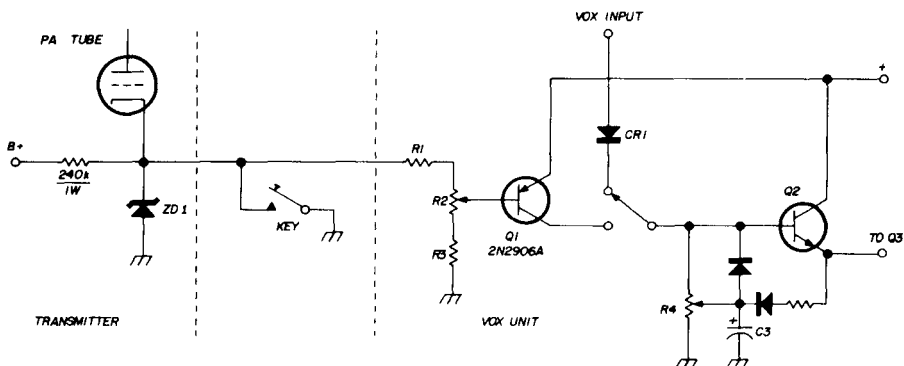
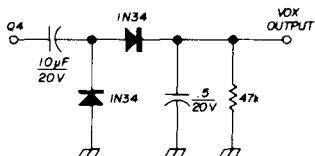


fig. 3. VOX modifications for use with cathode-keyed rigs. Value of resistor in tube cathode circuit is for  $B+ = 300$  volts. Zener-diode voltage is 60 volts dc at 1 mA.

hundred watts, the vacuum relay shown is recommended for its fast operation and ability to hot-switch several amps. K1, the other relay in my unit, is a small two-pole sealed 28-volt relay. I have tried other types, and the surplus 28-volt leaf-type relays will follow a key at moderate speeds. The extra noise created can be damped with felt between the relay and the chassis. Reed relays may of course be used, and some of the heavier ones may handle moderate powers.

an example, with the key down, Q3 is saturated with 120 mA through it in my vox unit, but the voltage across it is less than a volt. The power dissipated is less than 120 mW. When the key is released, however, the voltage across the transistor rises, and the current drops. At the point where 12 volts are across the transistor, 60 mA may flow through it for a short-term dissipation of 720 mW. The average dissipation, however, would be under 500 mW, and a 2N2222 could be used for Q3, but with little margin. At this point, a 2N2218A would be a good substitute (and far cheaper) for the 2N2219A.



2. Modifications necessary to author's ssb generator described in ham radio, December 1970 for use with this vox circuit.

If you wish to use whatever you can dredge up from the junk box, try the following measures to compensate for lower-beta transistors: decrease the values of R1, R2, R3 and R5. Operation with 12-volt relays requiring more current than those listed may also require a decrease in these resistor values.

## construction

My unit was built on a 1-1/2 x 2-inch piece of perf board, which was mounted on the rear of my transmitter chassis. R4, C3 and S1 are on the transmitter front panel, and R2 is on the chassis rear apron beside the perf board. Shielded wires to these controls are a must to avoid rf feedback. The antenna relay should be located remotely from the rest of the circuitry, and leads going to it should be well bypassed.

## other uses

The applications of this circuit are numerous. It could be added to a transmitter to eliminate throwing of switches to go from transmit to receive, or to control a linear you may have added to your station. It could be set up for battery operation with low-current relays and used on Field Day to mate someone's transmitter with someone else's receiver. It could also be used to key a tape recorder to record slow-scan tv or someone's voice. Or, how about recording passing satellite signals? Whatever your use, happy voxing!

## reference

1. R. Bain, W9KIT, "A Filter-type SSB Generator," *ham radio*, December, 1970, p. 6.

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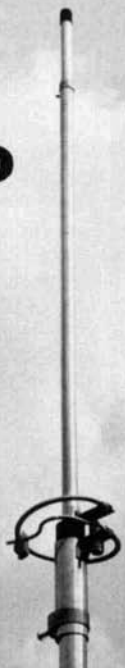
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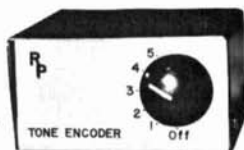
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# how to design a frequency calibrator for your receiver

Complete design procedure  
for a novel  
marker generator  
consisting of a  
constant-current source,  
unijunction oscillator  
and tuned output  
amplifier

Recent changes in amateur band-edge assignments for various license classes, and lack of crystal calibrators in many popular transceivers, has resulted in a rash of magazine articles on crystal calibrators. Some circuits are better than others and make provisions for 25-, 50- or 100-kHz checkpoints.

If you need a quick and handy crystal calibrator for your receiver, by all means

refer to any number of previously published articles. However, if you have a little time and want to learn a bit more about electronics, then read on.

The circuit presented here is absolutely *not* in the category of, "wire the parts together according to the given values and layout and you will have . . ." category. Rather, adequate design data is provided so you can calculate the required component values and make a breadboard with a minimum amount of the test equipment. The end result will be a useful, working calibrator that provides 100-kHz and 1-MHz reference points. More important, you'll learn a bit about electronics and why it isn't really too formidable to design and build simple circuits rather than going to the store for another piece of gear, or slavishly copying someone else's design without the foggiest notion of what to do if it fails to work when it is plugged in.

## the calibrator

The circuit in **fig. 1**, as opposed to the usual crystal-calibrator oscillator, relies primarily on the frequency stability of a low-frequency pulse generator that is used to supply impulse energy to a high-Q tank circuit tuned to 1 MHz. Although the oscillator is not crystal controlled the short-term stability will be more than adequate; long-term stability is primarily dependent upon the quality of key com-

Gary B. Jordan, W3AEX, 7185 South Birch Way, Littleton, Colorado 80122



ponents and regulation of the supply voltage.

The circuit can be broken into four easily understood sub-parts. Pnp transistor Q1 and its associated resistors (R1, R2 and R3) form an adjustable current source flowing from the collector of Q1. This current, I1, can be set to the desired value by adjusting the base voltage V1 with potentiometer R2. Current I1 will be very nearly (neglecting some fine points concerning base-emitter diode potentials):

$$I1 = \frac{E - V1}{R1}$$

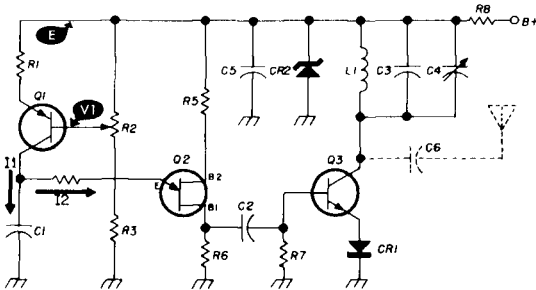


fig. 1. Stable frequency marker does not require a crystal-controlled oscillator stage. Component values are discussed in the text. Capacitor C6 and the antenna are used to transmit the marker signal to the receiver. Resistor R8 drops the B+ supply to the zener-diode voltage of CR2.

Current I1 charges C1 linearly to an increasing higher voltage until the threshold firing potential of the unijunction transistor is reached; at this point C1 is rapidly discharged through R4 into Q2. This process repeats indefinitely since Q2 will revert to a non-conducting state whenever the emitter voltage falls below a minimum called the valley voltage and current I2 is less than the holding current.

If an oscilloscope were used to look at the voltage across C1 it would display a very good sawtooth waveform; a linear voltage ramp due to the constant current I1 with a very fast return to near ground

when Q2 conducts. Therefore, two parts of the circuit are easily understood: Q1 is a constant-current source and C1 is a timing capacitor that determines how long it takes to reach the trigger voltage of Q2.

Transistor Q2 is nothing more than a simple unijunction transistor pulse generator. Whenever the emitter voltage reaches a certain fraction of the supply voltage E, a triggering voltage is reached which causes conduction between the two base junctions, thus causing B1 to suddenly jump up to a level near the emitter voltage. If the emitter voltage drops below some specified minimum conduction between B1 and B2 ceases. Thus, looking at R6 with a scope would show a squarewave pulse every time Q2 conducts.

Transistor Q3 is normally not conducting. The base is normally at ground potential through R7, and the voltage required to make Q3 conduct is at least two diode voltage drops — CR1 and the base-emitter diode of the transistor. Therefore the base must reach at least 1.0 to 1.2 volts before Q3 will be turned on.

However, each time a pulse appears at R6 it will be coupled to Q3 base by C2 briefly turning on Q3. If C2 is fairly small it will differentiate the squarewave pulse at R6 (a voltage spike will be observed at the base of Q3).

The final portion of the circuit consists of Q3 and its resonant tank circuit. Rather than being an ordinary tuned amplifier, this circuit could be called an "impulse driven resonator." Each time Q3 conducts because of a voltage spike from C2 energy is fed to the collector tank circuit. If the tank circuit has high Q it will continue to ring at the resonant frequency even though the initial energy supply is removed (Q3 stops conducting). The initial sine-wave energy at the resonant circuit will slowly diminish in amplitude but will be replenished when Q3 fires again. If the tank circuit is tuned to 1 MHz you have a 1-MHz marker plus plenty of harmonics to use as higher band-edge markers.

## circuit kinks

Although the foregoing discussion should be enough to get the circuit playing, a few more words should reduce the amount of "fiddle-time." Since you want a stable oscillator the supply voltage should be constant; a large electrolytic capacitor, C5, and an appropriate zener regulator can be used. The voltage is best chosen in the range of 12 to 28 volts dc.

Any old pnp transistor can be used for Q1. A value of 10k ohms for R2 and R3 is a reasonable starting value. Similarly, R4 isn't too critical since it is only used to limit the initial current surge into Q2; something in the neighborhood of 1000 ohms is reasonable.

Any problem likely to be encountered is in the choice of R1 and C1. A basic impulse rate that is a submultiple of 1 MHz is desirable so 100 kHz seems like a good basic frequency for the sawtooth at C1. However, current I2 *must* eventually diminish to a value less than the holding current for Q3 (on the order of 1 mA).

If I1 is greater than the holding current for Q2 (check the manufacturer's specs for this value) then Q2 will latch-up in the conducting state. Therefore the current selected for I1 must be less than the Q2 holding current or R4 made very large, which is not desirable. Similarly, to obtain a pulse rate of 100 kHz into Q2, C2 must be charged to the trigger voltage of Q2 at precisely that rate, every 10 microseconds. To pick the proper value for C2 once I1 has been selected use the equation

$$\frac{\Delta V}{\Delta T} = \frac{I1}{C1}$$

where the symbol  $\Delta$  means "rate of change." More simply, the voltage change at C1 (called  $\Delta T$ ) is equal to the ratio of the current I1 divided by the capacitance charged, C1 in this case. Since you know I1 (or can vary it slightly) and  $\Delta T$  is 10 microseconds, then the value of C1 is easily determined since the required value of  $\Delta V$  is the triggering voltage for Q2. (The triggering voltage is typically 0.25 to 0.5 the supply voltage.)

The unijunction transistor Q2 is fairly non-critical as to the values selected for R5 and R6. Resistor R5 usually ranges from 300 to 600 ohms; 100 ohms is a ballpark value for R6. Since you want some differentiation of the pulse delivered to Q3, capacitor C2 might be anything from 1000 pF to as much as 0.01  $\mu$ F.

Resistor R7 keeps Q3 reverse biased by draining off the reverse base-leakage current; for most small-signal transistors this leakage is so small that 100k ohms is a fair value for R7. Nearly any npn transistor will work adequately at Q3 such as an old 2N706 or 2N708.

The tank circuit (L1-C3-C4) should resonate at 1 MHz; a high-Q inductance is needed. This is easily obtained by using a ferrite toroid core and many turns of small wire. Capacitor C3 should provide most of the required capacitance, with C4 used for fine tuning. Alternatively, if L1 is variable C4 may be omitted. A wire antenna can be attached to the tank circuit to couple energy to your receiver.

## calibration

Circuit calibration may be accomplished by zero-beating the output against WWV. The primary variable will be R2 to obtain zero beat, with C4 used to obtain maximum power output. However, C4 will alter the output frequency slightly so some juggling back and forth between R2 and C4 will be needed initially.

Frequency stability will rival that of most crystal oscillators if two precautions are observed: The supply voltage must be stable, and C1 must not change capacitance radically with temperature. To a lesser extent, more expensive unijunction transistors have more stable trigger voltages that contribute a constant output frequency.

One nice feature of this circuit, aside from its low cost, is that if 100 kHz is picked as the basic pulse frequency, 100-kHz markers can be heard throughout the lower amateur bands and used as additional reference points.

ham radio



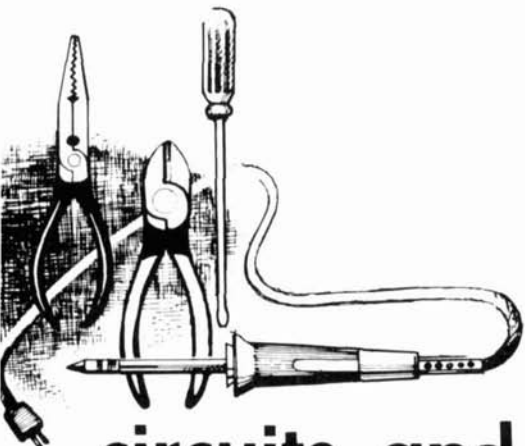
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# circuits and techniques

ed noll, W3FQJ

## integrated circuits

Many broadcast equipment manufacturers have taken advantage of digital ICs when designing new equipment. Such devices as JK flip-flops, divide-by-12 counters, divide-by-16 counters, 4-bit binary counters, etc. have found their way into a-m and fm broadcast transmitters. Radio amateurs and amateur radio equipment manufacturers might like to take a look at some of the possibilities.

One popular a-m broadcast transmitter uses two divide-by-2 binaries, **fig. 1**. The crystal oscillator frequency is set in the stable frequency range from 2 to 4 MHz spectrum. If the broadcast transmitter transmits between 540 and 1080 kHz, two 2-to-1 counters provide a net count down of four. If the transmitter must operate between 1080 and 1600, a single 2-to-1 counter is used to divide the frequency.

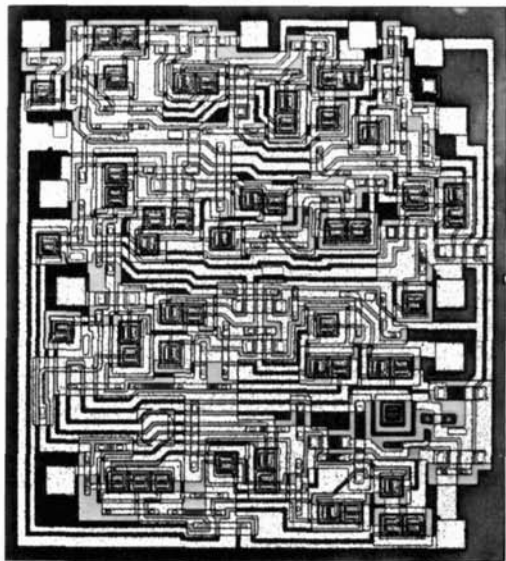
Digital ICs of this type generate square waves but this is no problem. Output

resonant circuits of appropriate Q can convert the square wave to a pure sine wave. The input to the counter should be a square wave; this can be accomplished with a simple limiter at the output of the crystal oscillator.

Some modern fm transmitters use elaborate digital counter chains such as **fig. 2**. This arrangement permits the frequency-modulated oscillator to operate at the fundamental frequency of the fm station. An automatic-frequency phase-lock system keeps the oscillator on the assigned frequency well within FCC tolerance ( $\pm 2000$  Hz on the fm broadcast band).

In one fm broadcast transmitter an output from the basic oscillator is applied

One of Motorola's newer MRTL digital ICs is the MC880P, a decade counter that also divides by five or six with the proper external connections.



to a 16,384-to-1 counter and then to a phase comparator. The crystal reference oscillator operates in the 1.5- to 2-MHz range, depending upon the assigned frequency of the fm station. This reference frequency is divided by 256 and applied to the phase comparator. The phase comparator develops a dc reference voltage which keeps the transmit oscillator on frequency.

For such a divider system, the digital ICs must be capable of operating at very high frequencies. Such units are available at low cost. For example, a 120-MHz J-K flip-flop has a unit cost of approximately \$7.50. A flip-flop with a maximum input frequency of 85 MHz can be purchased for about three dollars. A divide-by-16 counter with a maximum frequency of 30 MHz can also be purchased for about

division of 4 and put the signal into the 160-meter band, fig. 3.

Digital ICs that can be connected as astable multivibrators can also be made to

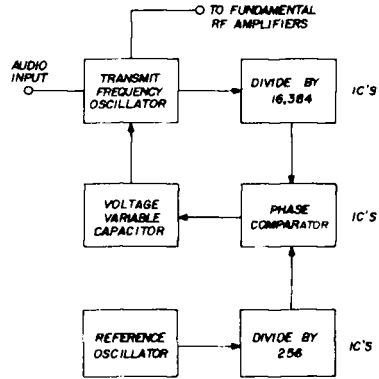


fig. 2. Integrated circuits in a phase-lock system determine the operating frequency of this fm broadcast transmitter.

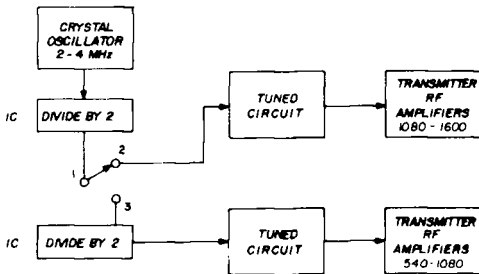


fig. 1. Circuit for using IC frequency dividers in a-m broadcast transmitters.

multiply. Is it possible to build an IC substitute for the common frequency-multiplier chain? The arrangement of fig. 4 might be feasible as an all-band signal source or as an accurate all-band signal source and calibrator. Two-times the 7.5-MHz master-oscillator signal provides a WWV check point at 15 MHz.

Reconstructing a sine wave from a square wave output is no great problem

\$7.50. A search of the surplus market may yield the same or similar units at even lower prices.

### practical frequency dividers

What are some of the possibilities for amateur equipment? Amateurs are accustomed to using frequency multipliers that develop signals related harmonically to a crystal oscillator or vfo. A digital divider system permits decreases in frequency. For example, a divide-by-2 counter following a 40-meter vfo that tunes from 7 and 8 MHz will give an 80-meter output between 3.5 and 4 MHz. Two 2-to-1 dividers would provide a net

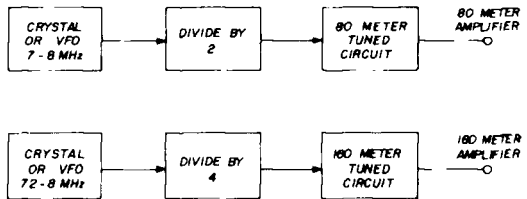


fig. 3. Two possible circuits for using IC frequency dividers in amateur radio equipment.

with resonant circuits or multisection integrators. However, you are working with pulse waveforms and their multi-frequency makeup, so proper shielding and grounding is important.

This scheme is attractive for all-band QRP operation and it matches the various QRP modes of cw, a-m, dsb and phase-type ssb. There is also merit in terms of the direct-conversion receiver because you can work both down- and up-frequency from a single high-stability beat oscillator.

For vhf operation IC frequency dividers can be used to put the transmit oscillator on the transmit frequency, doing away with the multiplier chain. A possible system for 2- and 6-meter operation is shown in fig. 5. A divide-by-8 circuit brings a fundamental 6-meter signal down to the 7-MHz range where it is compared with a crystal oscillator, vxo or stable vfo. The two signals are applied to a phase comparator (also available as a digital IC). A dc afc voltage is developed for controlling the fundamental frequency oscillator, holding it on frequency. The fundamental frequency oscillator uses a voltage-variable capacitance diode that responds to the phase-lock afc system.

For 2-meter operation an 18-to-1 frequency divider brings the fundamental

frequency down to the 8-MHz range for comparison. Otherwise, the system is the same as 6-meter arrangement. Also, this configuration is adaptable to various modes of modulation. Frequency modulation may even be accommodated. However, frequency division must be greater to prevent the modulating frequencies from affecting the phase-lock operation.

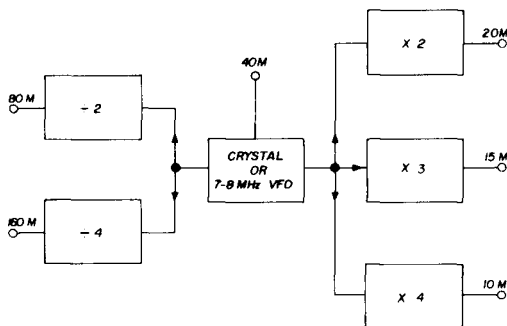


fig. 4. An all-band high-frequency signal source using a single 40-meter oscillator.

### simple rf divider

The feasibility of this frequency-control circuit was checked out with a low-cost MDTL clocked R-S flip-flop, wired externally to operate as a J-K flip-flop. The frequency divider was used with the fet circuit described in the June issue.

The output of the Pierce crystal oscillator, fig. 6, is fed directly to the clock input of the flip-flop. A shaping diode is connected between pin 2 and common. The flip-flop is biased with a 9-volt transistor radio battery.

A tuned fet rf amplifier follows; it is operated in class A because of limited drive from the flip-flop. Nevertheless, approximately 200 milliwatts of rf output is developed. But more important, a beautiful 80-meter sine wave may be observed at the output. A local 80-meter QRP contact using a 40-meter crystal is something a bit different from the ordinary.

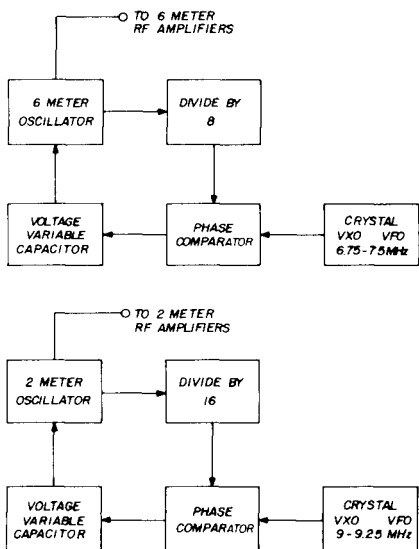


fig. 5. Using IC frequency dividers in frequency-determining systems for 6 and 2 meters.

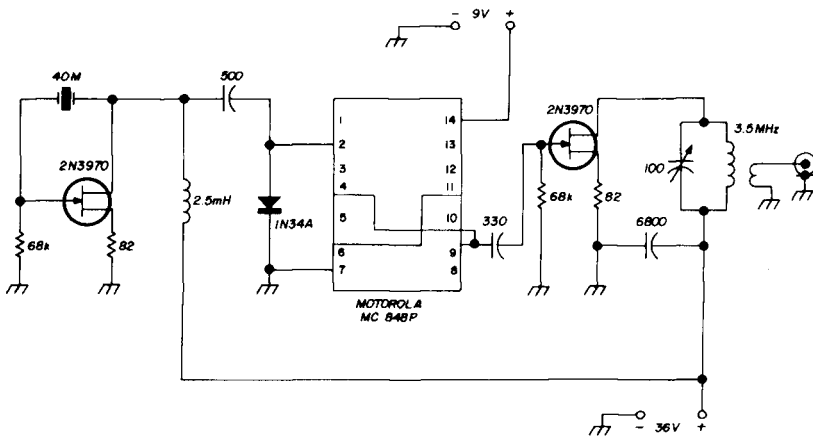


fig. 6. This QRP transmitter for 80 meters uses a 40-meter crystal and IC 2:1 frequency divider.

### high-power audio

An unusual two-section high-power audio amplifier, the RCA HC-1000, is capable of delivering 100 watts into a 4-ohm load with a peak current of 7 amperes. The total supply voltage is 75 volts. An output transformer can be added to step up the impedance when

required; this may be necessary if the unit is used to supply audio to a vacuum-tube modulated amplifier.

The price of the HC-1000 is in the \$60 bracket. This might shake you a bit but consider what it would cost to build a vacuum-tube modulator capable of de-

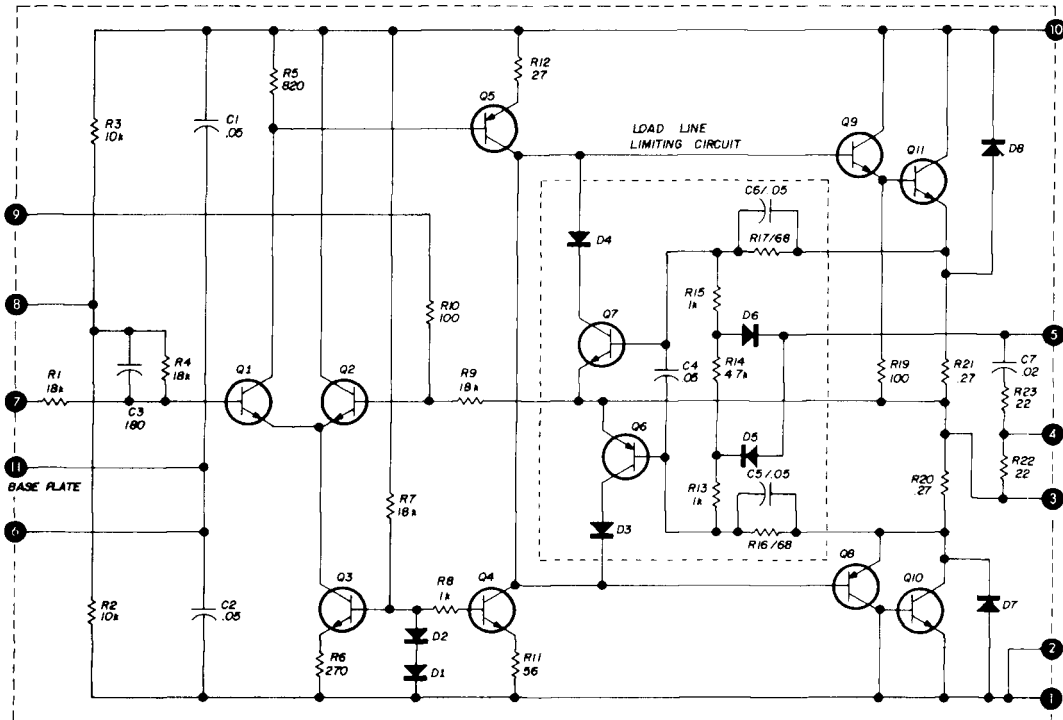


fig. 7. Internal circuit of the miniature RCA HC-1000 100-watt audio power amplifier.

livering 75 to 100 watts of audio? Consider too that the entire HC-1000 module is 3 by 3-1/2 inches and weighs but 100 grams.

The amplifier consists of two separate

module when an improper load is placed on the output. Transistors Q9-Q11 and Q8-Q10 are Darlington pairs that develop a high-power output across a low impedance load. The input impedance to

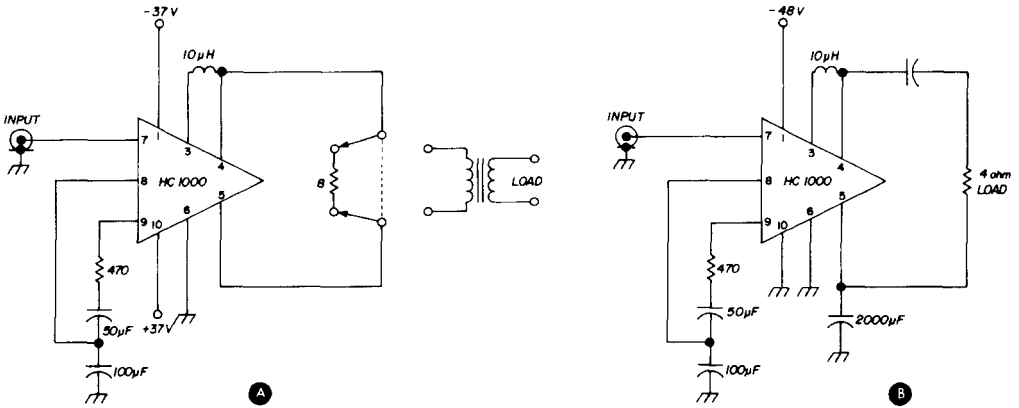


fig. 8 Practical audio power amplifiers using the HC-1000. Circuit in (A) requires both positive and negative voltages; circuit in (B) requires only negative supply voltage.

sections mounted on a common base plate. One section serves as the complete driver and includes 23 resistors, 7 capacitors, 6 diodes and 9 transistors. Two power output transistors and two diodes are contained in the second section.

A schematic diagram of the HC-1000 is shown in fig. 7. The input stage (Q1 and Q2) is a differential amplifier with a constant-current bias source (Q3). Note the temperature-stabilizing diodes in the base circuit of Q3.

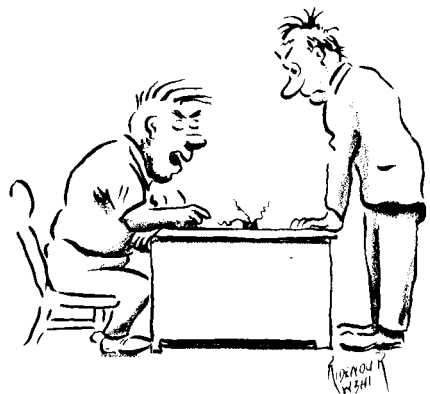
The collector of Q1 supplies output to the base of a class-A amplifier (Q5). Transistor Q5 supplies drive to the two pairs of output transistors. The collector of Q5 is connected to the collector of Q4; Q4 is also a constant-current source but its purpose is to supply a bidirectional current in proportion to the current through Q5. It acts as a level translator to ensure that no dc offset voltage is applied to the output transistors. Such a dc voltage would be contributed by Q5 if it were not balanced out by the voltage developed by Q4.

The protection circuit within the dashed block prevents damage to the

this stage is high enough to attain good gain from the class-A amplifier (Q5).

The HC-1000 circuits in fig. 8 are designed for a positive and negative power supply (fig. 8A) or a negative power supply (fig. 8B). Circuit 8A includes an output transformer for providing a proper match to a specific load resistance.

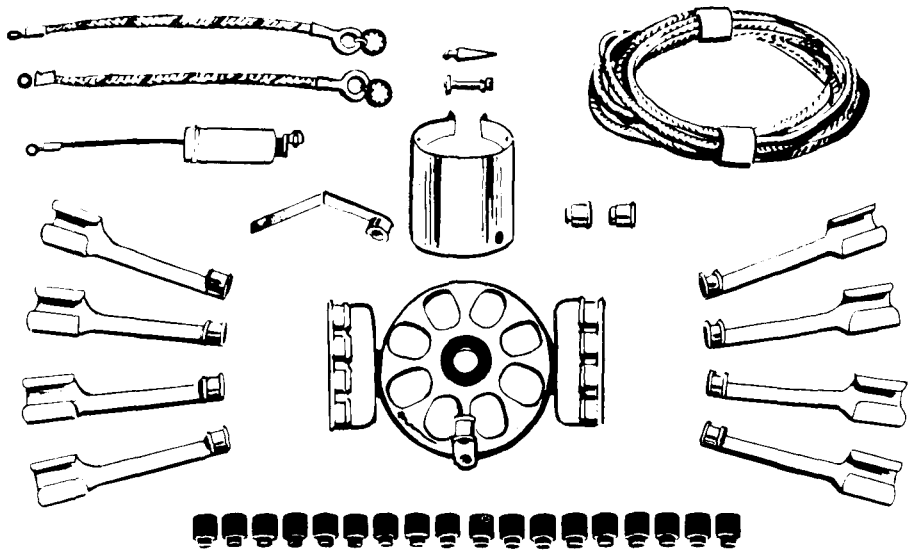
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"This used to be an integrated circuit — until my wife thought it was a spider and stepped on it!"



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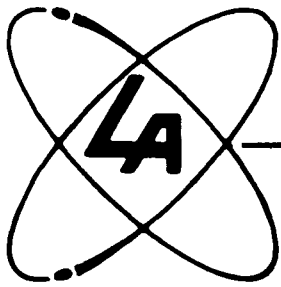


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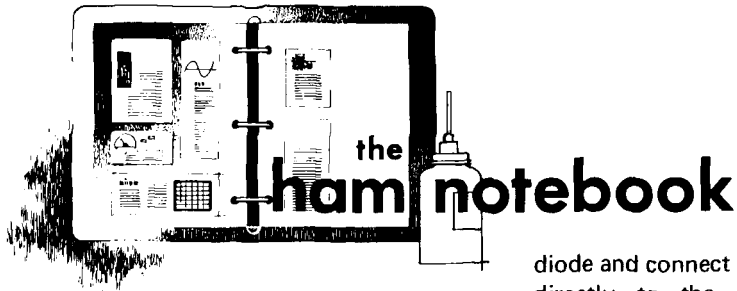
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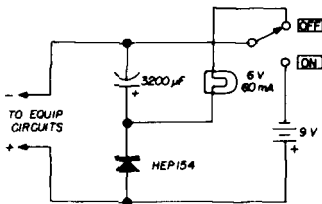
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## switch-off flasher

Portable solid-state equipment that is designed for low power drain often excludes the use of "high-drain" pilot lamps. The circuit in **fig. 1**, designed by S. Thomas and described in *The Radio Constructor*, flashes the light after the switch is turned off. The circuit is applicable to any transistor equipment that uses a 9-volt battery. When switch S1 is *on* the capacitor is charged through the diode; when the switch is turned *off* the 6-volt lamp is connected across the capacitor, causing the bulb to flash brightly. The circuit draws negligible battery current; in Mr. Simon's unit the leakage current drawn by the capacitor was measured at 6  $\mu$ A.

The capacitor cannot discharge the equipment circuits because of the diode. However, if the equipment has a large-value capacitor across the power supply, it will discharge through the diode into the lamp, increasing the length of the flash. With most equipment it would probably be possible to eliminate the



**fig. 1.** Simple low-drain circuit flashes when the switch is turned off. Current drain is less than 10  $\mu$ A.

diode and connect the capacitor and lamp *directly* to the negative supply lead, although this should be checked experimentally.

## receiver incremental tuning for the swan 350

Although receiver incremental tuning is not an *absolute necessity*, at times it is a pleasant convenience. The circuit in **fig. 2** is quite basic and may be added easily to the Swan 350.

Most of the smaller component parts may be mounted on a small 6-lug terminal strip which is mounted under the left-rear mounting nut of the vfo printed-circuit board (as viewed from the front with the Swan on its back). This provides a short, direct connection between C1 and the collector of the oscillator transistor, Q1, by soldering to the lead which comes from the dial set and tuning capacitors; this lead is connected to the vfo board at the small solder blob immediately in front of the mounting screw that is used to mount the terminal strip. Use a piece of good stiff wire here to prevent any unwanted fm-ing due to vibration.

Location of the other components is not critical. In my unit CR2 and R4 were mounted on a terminal strip adjacent the voltage regulator tube, V16. The relay was mounted immediately behind the vfo box near the two elongated chassis cut-outs. The RIT pot was mounted on the front panel between the dial window and the plate tuning control. Although I

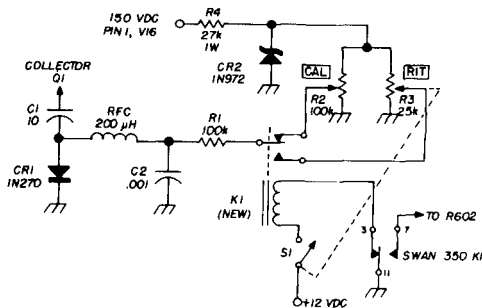


fig. 2. Incremental tuning circuit for the Swan 350. Relay K1 is a miniature 12-volt spdt relay such as the Potter & Brumfield KM5D. CR2 is a 30-volt, 400-mW zener.

mounted the *calibrate* pot on the front panel above the RIT pot, it may be mounted internally on a small bracket. The wires were routed through the small chassis hole near the vfo amplifier tube.

Calibration is accomplished by first setting both pots to the middle of their ranges. Feed in a crystal-calibrator signal and pull out on the RIT knob, leaving it at center. Now zero beat the calibrate signal with the main tuning knob. Push the RIT knob in (*off*) and adjust the *calibrate* pot for zero beat. This insures the transmit and receive frequencies are the same with the RIT function disabled while allowing manual control of the *receive* frequency with the RIT on.

The installation of the circuitry upsets the dial calibration very slightly; it was

found the dial-set capacitor easily re-stored calibration. With the circuit constants shown,  $\pm 3.5$  kHz frequency deviation was obtained. With this amount of shift you may take a station from zero-beat and move the signal out of the passband of the filter in either direction.

Paul Pagel, K1KXA

## crystal-controlled multivibrator

The crystal-controlled oscillator circuit shown in fig. 3 uses no tuned circuits. Since there is no reactance in the circuit except for the small gimmick capacitor, the circuit will oscillate at any frequency from 2.5 kHz to 15 MHz by simply changing the crystal. Rf output voltage is approximately the same as the supply voltage, which can be from 6 to 25 volts.

I have used this circuit as a wideband frequency spotter, as a marker generator (output is rich in harmonics), and as a crystal activity and stability tester.

When building the oscillator, keep all interconnecting wires as short as possible. Although it is not required in every case, you may need the gimmick capacitor to obtain oscillation. The gimmick is made by twisting together two 2-inch pieces of insulated hookup wire; make sure the two wires don't short together.

Mike Centore, WN2MQY

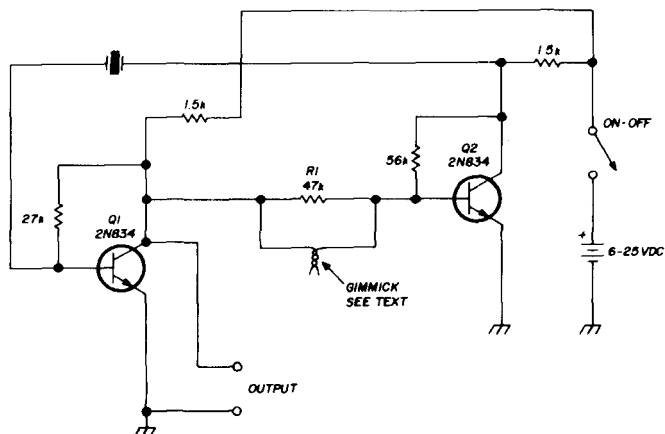


fig. 3. Crystal-controlled multivibrator uses no tuned circuits but will oscillate at any frequency between 2.5 kHz and 5 MHz by simply changing the crystal.

## versatile resistor decades

Accurate decade standards may be assembled at considerably less than their usual cost by using one of the switching arrangements shown in fig. 4 and 5. The precision components represent the greatest cost of a decade standard; therefore, any reduction in the number of components directly reduces cost.

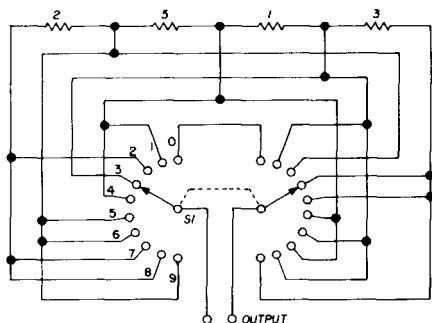


fig. 4. Zero through 9 ohms are obtained by switching various combinations of four standard resistors. For higher resistance values the resistors are increased by factors of ten. The switch is a 2-pole 10-position rotary.

Only four precision resistors or capacitors are required in this design, instead of the usual ten. This savings may be used to simply reduce cost, or if you wish, to buy closer tolerance components for a more accurate decade.

Several construction precautions should be observed. Low-resistance decades require very low contact resistance switches to preserve accuracy. This requirement may be met by parallel wiring two decks of a conventional rotary switch, instead of single decks shown in fig. 4.

In capacitance decade's low-value capacitors must be well spaced from all metallic components to reduce errors due to stray capacitance effects. Also, wide spacing between capacitor terminals and jumpers is required. In the low-capacitance and high-resistance decades, rotary switches with ceramic insulation are recommended.

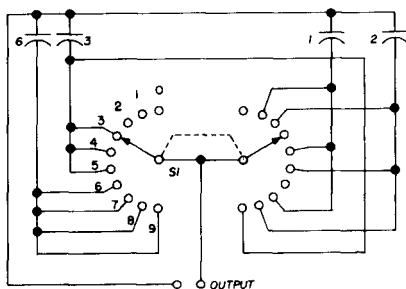


fig. 5. Nine individual capacitance values are provided by switching combinations of four capacitors. Switch is a 2 pole 10-position rotary.

The economical decade switching systems shown here may be extended to the design of other useful decades including inductance, zener diodes and back-to-back diode clippers.

Gene Brizendine, W4ATE

## vfo buffer amplifier

The solid-state vfo I described in the August, 1970 issue of *ham radio* was designed to provide a high-quality stable signal at low output to replace crystals in low-power solid-state transmitters. It is essential in any vfo that oscillator loading be as small and constant as possible (to produce a chirpless signal). This was achieved in my vfo by voltage regulation and by using a low-load buffer stage. The third stage was designed to match the high-impedance output of the jfet buffer stage to the low-impedance input of a solid-state transmitter. Consequently, there is little amplification of the oscil-

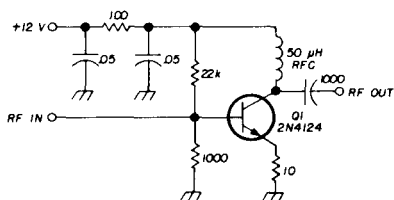


fig. 6. Solid-state vfo amplifier provides constant high-impedance load to the vfo. RFC1 is a Millen 34300-50.

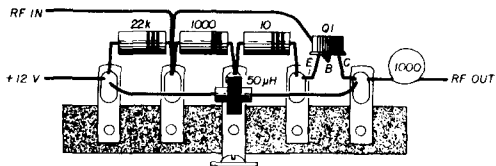


fig. 7. Vfo buffer amplifier can be built completely on a 5-lug terminal strip.

lator signal; output voltage is about 1.5 volts maximum.

If you need more output for this or similar solid-state vfo you may be interested in adding the simple one-stage amplifier shown in fig. 6. This amplifier will provide plenty of power to the driver stage of a transistor transmitter up to the five-watt class, and can be built for under \$3.00 using all new parts. This circuit will fit nicely into the W3QBO vfo minibox; or, it can be built into the associated transmitter.

The components can all be neatly mounted on a 5-lug terminal strip as illustrated in fig. 7. The schematic shows a 100-ohm resistor and two .05- $\mu$ F bypass capacitors for power-lead decoupling, a practice that should always be followed. The Motorola 2N4124 transistor sells for 60 cents; many other transistors (such as the Motorola 2N3904) will work well in this circuit but usually they will cost much more.

C. Edward Galbreath, W3QBO

## vhf a-m modulation monitor

If you have a dc-coupled oscilloscope in the shack, such as the EICO 460, here is a low-cost and simple method of keeping track of your percentage of modulation. At vhf the usual techniques of envelope patterns and trapezoidal patterns become very difficult, if not impossible. The method shown in fig. 8 is based on the fact that the plate voltage applied to an amplitude-modulated stage varies between zero and twice the dc supply voltage for 100% modulation of a properly adjusted a-m transmitter.

Connect the vertical scope input to the modulated dc which feeds the modulated rf stage. A resistive voltage divider (no capacitors) is necessary if the voltage is high enough to be dangerous. Select a convenient sweep rate of about 100 Hz or so. Position the horizontal trace so it coincides with one of the lower graticule lines. Apply plate voltage to the modulated stage (with no modulation) and adjust the vertical gain control to

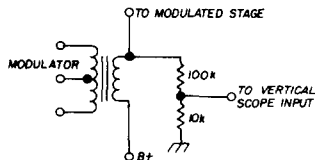


fig. 8. Resistive divider is used to pick off signal for a-m modulation monitor.

move the horizontal trace to the center graticule line. The scope is now set up to show modulation amplitudes varying around the dc supply voltage.

Audio modulation gain should be adjusted to keep the scope pattern between the limits of the lower (zero volts dc) graticule line and the corresponding graticule line above the center. Fig. 9 shows the relationships. For my equipment, with a 750-volt dc power supply, I chose a resistive voltage divider of 100k and 10k. A suitable ratio permits convenient measurement of the final dc supply voltage without exposure to lethal high voltages.

Harry Ferguson, K7UNL

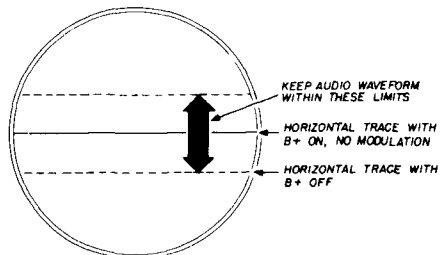
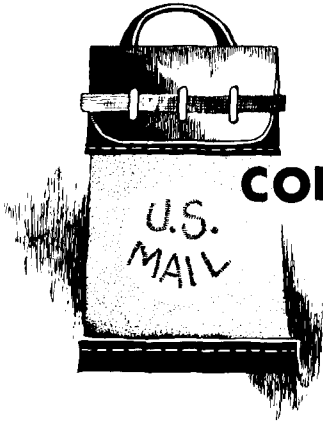


fig. 9. Modulation percentage is less than 100% if waveform is between limits shown here. Equipment setup is described in text.



## comments

### QRP technique

Dear HR:

W6NIF's article on QRP technique in the December issue was interesting and valuable. But it seems to me that QRP has another facet which might be of immediate concern to more amateurs. Personally, I have the utmost respect for those, like Al Wilson, who persist with real flea power. I wish I had the time and patience to do so. However, to me *practical* QRP means power inputs of the order of five watts.

Now that the southern gentlemen at Ten-tec have introduced so many of us to this fascinating QRP world we may learn what we should have known for years. Most of us regularly use from five to one-hundred times more power than we need, or ought to use. We QRM the world for our ego's sake.

For almost a year now, I have not used *more than eight watts dc* power input to the final stage, and I have had more fun in the game than ever. Using both a Ten-tec rig, and a number of homebrew jobs, I have enjoyed as many *solid* QSOs as I formerly did with a ninety-watter. In fact, most folks worked do not know I'm QRP until I tell them. And I use a most unpretentious antenna, an 80-meter zepp, up only about 25 feet. Folks with

*good* antennas, and perhaps more skill, do better. But I've worked 20 countries, 24 states, and all parts of Canada, and relished it immensely. Furthermore, I don't feel like an "ugly American."

To me, this is *amateur* radio, as contrasted with the expensive, tinsel world of "commercial" ham radio that one hears, particularly in the phone bands, where power seems valued for its prestige alone. Less-than-one-watt QRP is interesting and may constitute a valid achievement. But few of us have the time, the patience and perhaps the skill for this. All of us, however, could cut our power input to one-tenth of its present level, have as many fine QSOs as ever and thereby vastly improve the American amateur's electronic world image. This in itself, in these times, would seem worthwhile.

C. F. Rockey, W9SCH  
Deerfield, Illinois

### fire extinguishers

Dear HR:

The January article, "Fire Protection in the Ham Shack," is a very important and timely subject. However, I question the statement about Freon not being as toxic as carbon tetrachloride is. My experience indicates that Freon is highly toxic when exposed to high temperatures.

For a number of years I was in the air-conditioning trade. In one case a Freon-refrigerant discharge line broke in an air-conditioning system in the basement of a hotel; in the same room with

the broken line there were several gas-fired hot-water heaters. When the freon broke down in the flame it formed phosgene gas — the same results produced by carbon tetrachloride. I was extremely sick from being exposed to the fumes, and it was some time before I was well again. I would suggest ventilation as soon as possible if using a Freon-type fire extinguisher; in fact, in my book, this goes for the use of any aerosol cans.

**Orville Gulseth, W5PGG**  
Clarksdale, Mississippi

## frequency-sensitive resistors

Dear HR:

I am a sales engineer, and the following comments come from 18 years of selling resistors. Contrary to popular belief, deposited carbon-film, metal-film, and the like, are *not* non-inductive resistors. After the resistive material is deposited on the ceramic core the resistive material is cut into a spiral, with 12 or more turns before the desired resistance value is obtained. The result is a 12-turn coil of resistive material plus some capacitance thrown in for good measure.

If you want a true non-inductive resistor you must tell the manufacturer what frequency you will use, and then stay close to it. For all-around general-purpose non-inductive resistors for all frequencies the old carbon-composition resistor is hard to beat.

**Ed Aymond, W5UHV**  
Dallas, Texas

## more uses for the ST-6 RTTY demodulator

Dear HR:

Although the ST-6 was not designed with computer work in mind, the time constants are adequate even for 220 Baud. Computers use 8-level 100-speed

teleprinters such as the model 33 or 37. This is 110 Baud, considerably shorter pulses than the normal 5-level 100-speed teleprinters used on many MARS frequencies.

The ST-6 operates in a normal manner even at 200 Baud, with the change of two resistors and one capacitor in the low-pass filter. I am using such a modified unit at home in conjunction with a cathoderay type computer terminal.

The ST-6 can also be used with the AK-1 AFSK unit (*QST*, February, 1965) and a phone patch as a computer interface between the phone line and the computer terminal. (The AK-1 also performs in excess of 220 Baud.) Such use would not appeal to many hams at this time, but the possibility is always there if you need it.

**Irv Hoff, W6FFC**  
Los Altos, California

## motrac receivers

Dear HR:

In the December, 1970 issue, the *ham notebook* recommended the Motorola Motrac receiver for use in repeaters. It should be noted that there are two basic types of Motrac receivers.

The type-L receiver uses a bipolar rf amplifier stage and is a poor choice for just about any fixed-station application. Its desensing characteristics are 5 to 10 dB inferior to the tube-type G receiver, and 10 to 15 dB worse than the old type-A receiver. The intermod characteristics are even worse: 10 to 15 dB more than the G, and 20 to 25 dB more than the A. The later type-M receivers use a fet mixer in the front end; it is about equal to the old type-A in desensitization, and far, far better in the intermod department.

The order of preference for Motorola receivers is the type-M (new Motrac), type-A (wide-chassis tube type), type-G (narrow-chassis tube type), and last, the type-L (early Motrac).

**J. A. Murphy, K5ZBA**  
Tulsa, Oklahoma

# RSGB PUBLICATIONS

## AMATEUR RADIO TECHNIQUES

J. Pat Hawker, G3VA

Do you have the time to review all the dozens of amateur and commercial magazines which are brought out each month to collect the best of their many good new ideas.

Here it has already been done for you in this very complete collection of material taken from a number of periodicals. It is presented in a most useful and well organized manner.

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G. R. Jessop, G6JP

Have you ever spent half an hour or so going through all kinds of literature looking for a good basic amplifier or oscillator to put into that new design of yours? In this collection you will find several examples (using both semi-conductors and vacuum tubes) of each type of circuit you might need.

Typical headings include Antenna Matching, T-R Switches, Preamplifiers, Converters, I.F. Stages, Noise Limiters and Blankers, Power Amplifiers, Linear Amplifiers, Audio Amplifiers, Keyers, Oscillators, Power Supplies, Test Equipment and many more.

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It includes numerous technical and construction articles in addition to a complete run-down on the month's events in amateur radio. Surely a most interesting addition to your amateur radio activities.

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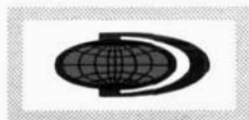
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# new products

## audio sweep generator



The new Rameco ASG-1 audio sweep/signal generator was developed for use in the frequency range of zero to 100 kHz. Its prime purpose is to display the response characteristics of either active or passive circuits on a standard oscilloscope. Both swept and cw modes of operation are provided; sweep width is variable from a few Hertz to 100 kHz in a single sweep. Output is adjustable from 0 to 5 volts peak to peak. A synchronized ramp output with adjustable amplitude is supplied for driving the horizontal input to the oscilloscope. If triggered operation is desired, generator blanking pulses are available. Sweep time is variable from 20 milliseconds to 20 seconds. \$195.00 from Rameco Corporation, Post Office Box 580, Deerfield Beach, Florida 33441. For more information, use *check-off* on page 94.

## two-meter fm rig



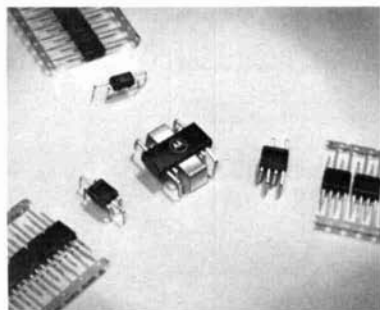
Simpson Electronics has announced a new low-cost vhf-fm mobile rig for the amateur who wants to operate on two-meter fm. The 6-watt *Simpson Model A* features four channels, sensitivity of 0.6  $\mu\text{V}$  for 20-dB quieting and separate plug-in transmitter and receiver boards with easy access to all tuning and metering points. The solid-state design uses integrated circuits and diode frequency switching.

The squelch is fully regulated and compensated with squelch sensitivity at 0.25  $\mu\text{V}$  or less. Intermodulation interference rejection is 70 dB minimum. Spurious response attenuation is greater than 60 dB. Selectivity, furnished by ceramic filter, is 13 kHz at 6 dB down and 36 kHz at 60dB down. Audio output is 2 watts with less than 10% distortion. Current drain on receive: squelched, 250 mA; unsquelched, 480 mA.

The transmitter has  $\pm 5$  kHz deviation for 100% modulation at 1 kHz and includes instantaneous automatic deviation limiting. Transmitter audio response is +1 dB to -3 dB from 300 to 3000 Hz. Tuning range is 144 to 148 MHz.

The *Simpson Model A* comes complete with mounting cradle and press-to-talk microphone with coil cord. Simpson furnishes crystals for operation on 146.34/146.94 and 146.94/146.94 MHz. The *Simpson Model A* is priced at \$249, including four crystals. For more information write to Simpson Electronics Inc., 2295 Northwest 14th Street, Miami, Florida 33125, or use *check-off* on page 94.

## motorola functional circuits



Motorola's recently introduced line of low-cost *functional circuits* now totals twenty devices. Included are flip-flops, voltage regulators, general purpose and audio amplifiers and an electronic attenuator.

Functional circuits provide common circuit functions where discrete tran-

sistors cannot economically be used. These are generally circuits where matching or balance or component density can better be achieved on a single chip, and include complex digital and linear functions such as multipliers and demodulators.

Functional Circuits are supplied in new, low-profile, plastic packages specially designed to use minimum printed circuit board area yet maximize pin spacing for easy, reliable soldering. The twenty functional circuits are listed below:

For further information, write to Technical Information Center, Motorola Semiconductor Products, Inc., Post Office Box 20924, Phoenix, Arizona 85036, or use *check-off* on page 94.

application	function	device number	price (1-9)
audio outputs	.25 W out audio	MFC4000A	\$1.35
	1.0 W out audio w/preamp	MFC6070	\$1.55
	1.0 W out audio w/preamp	MFC8010	\$2.94
	4.0 W out audio w/preamp	MFC9000	\$4.57
	2.0 W out audio w/preamp	MFC9010	\$3.53
	2.0 W out audio w/preamp	MFC9020	\$3.25
audio drivers	class-A driver	MFC4050	\$1.26
	class-B driver	MFC8020	\$2.38
general purpose amplifiers	wideband gain block	MFC4010A	\$1.26
	fm i-f differential amplifier	MFC6010	\$1.08
	flexible differential amplifier	MFC8030	\$1.65
	low noise preamp	MFC8040	\$2.13
digital	single-toggle flip-flop	MFC4040	\$1.35
	double-toggle flip-flop	MFC6020	\$2.70
	double-toggle flip-flop w/&reset	MFC6050	\$1.65
	J-K flip-flop	MFC8050	\$1.98
voltage regulators	8-30 V regulator 1 W, 200 mA	MFC4060	\$1.41
	8-30 V regulator 1 W, 200 mA	MFC6030	\$2.77
	8-30 V regulator 2.5 W, 200 mA	MFC9030	\$3.60
	w/current regulator		
control circuit	electronic attenuator	MFC6040	\$1.98

## vhf fm catalog

The recently published 1971 catalog from Gregory Electronics features a complete listing of equipment for the vhf fm operator including General Electric Progress, Pre-Progress and Pacers; Motorola Mobile units, Motrac, Motorcycle Dispatcher, etc; as well as commercial equipment manufactured by Dumont, RCA and Bendix. Gregory Electronics has a wide stock of fm equipment in stock, including gear for low-band (30 to 50 MHz) mobile and base stations, high-band (150-174 MHz) mobile and base stations and uhf (450 to 470 MHz) mobile and base stations, plus remote controls and various parts and accessories. For the serious vhf fm operator the new 1971 Gregory Catalog represents one of the most complete listings of vhf fm equipment, with descriptions, available to the amateur. For your copy, write to Gregory Electronics Corporation, 249 Route 46, Saddle Brook, New Jersey 07662, or use *check-off* on page 94.

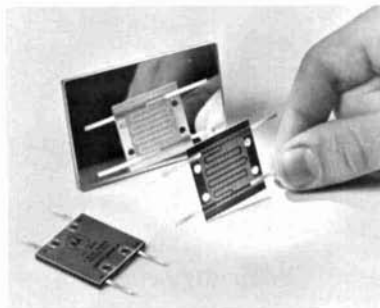
## motrac tone kit

The addition of sub-audible continuous-tone squelch to Motorola Motrac radios has been made easy by the new Alpha MK-21 Motrac tone mounting kit. The MK-21 makes possible rapid conversion of previously non-toned Motrac radio units, a heretofore difficult problem. Radio systems employing so called "NON PL" Motracs can be updated and made more efficient, relieving the user from listening to co-channel congestion. Because the Alpha tone unit is completely compatible with existing "Private Line," "Channel Guard," "Quiet Channel" and other sub-audible tone devices, the non-tone Motrac can be put into service in existing toned systems, thus extending the useful life of these fine radios. Also available from Alpha is an optional two-frequency tone unit that allows for selective control of repeaters, base stations, etc. The MK-21 uses the plug in the ST85H encoder or the SS80H encoder/decoder. Simple step-by-step in-

stallation instructions are provided, and a wide range of EIA tone frequencies is available.

For information write to Alpha Electronic Services Inc., 8431 Monroe Avenue, Stanton, California 90680 or use *check-off* on page 94.

## uhf quadrature coupler



Multiple-device combining, transmission continuity and mismatch isolation are three major performance advantages afforded by the Motorola MIC5830-31, 3-dB quadrature coupler.

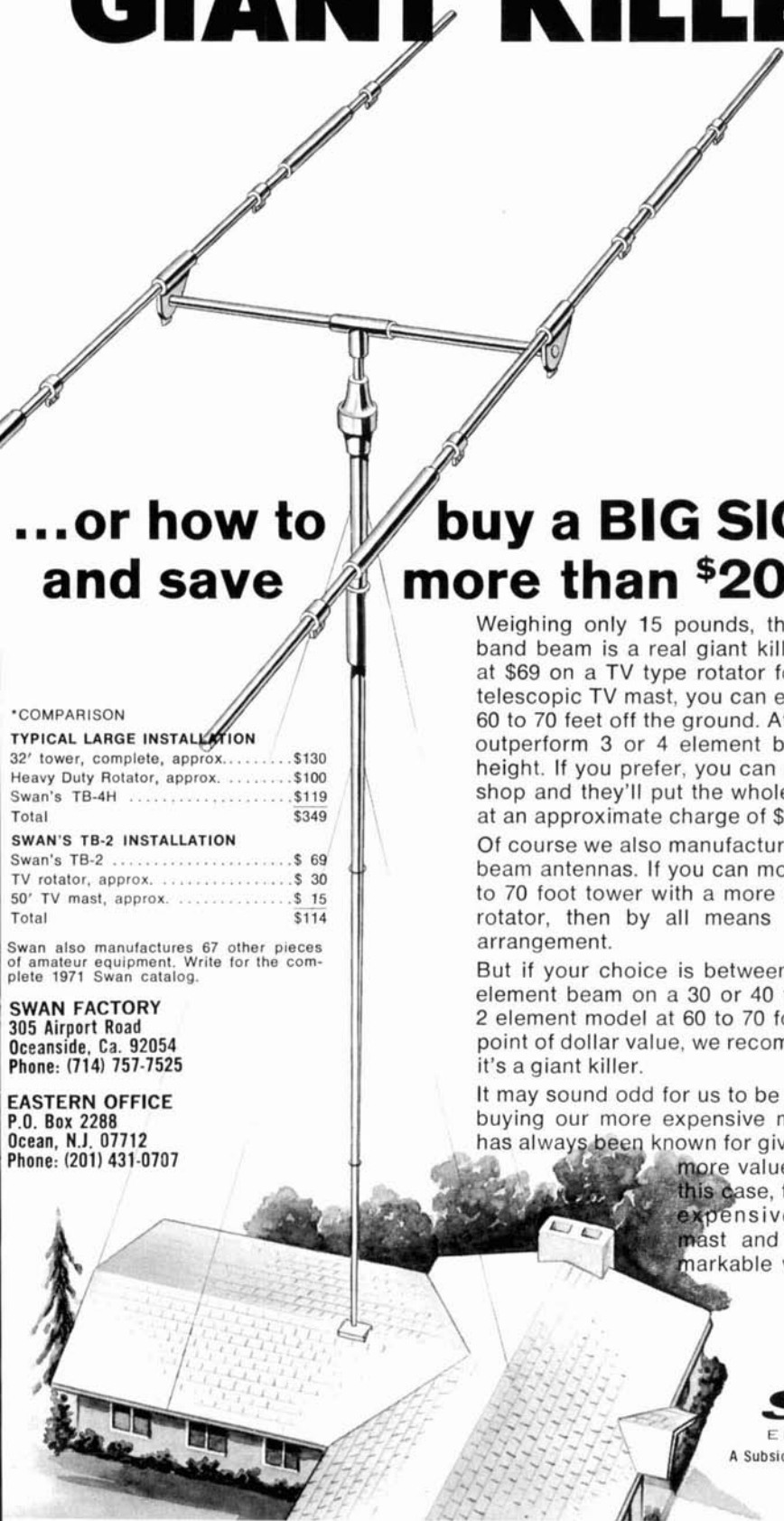
Mismatching of transmitter ports, for example, is reported no longer a problem because the application of a reflected signal at either of the output ports results in signals at the input port attenuated by 20 dB. Insertion loss is as low as 0.25 dB maximum, affording greater output power; phase balance is  $\pm 1.5^\circ$  maximum, furnishing smaller combining losses and less distortion.

Efficiency in higher frequency designs, such as broadband military and ECM equipment is also heightened through elimination of power-robbing, load-balancing passive components which constrict bandwidth. Usable frequency capability ranges from 225 to 400 MHz and 450 to 512 MHz.

The stripline, broadside devices are constructed from Teflon fiberglass board and sealed with a low loss, low dielectric compound. Small size is achieved by meandering the coupled lines.

For complete specifications write to Motorola Semiconductor Products, Inc., Box 20912, Phoenix, Arizona 85036, or use *check-off* on page 94.

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Weighing only 15 pounds, the Swan TB-2 tri-band beam is a real giant killer. With the TB-2 at \$69 on a TV type rotator for \$30, and a \$15 telescopic TV mast, you can easily get the TB-2 60 to 70 feet off the ground. At that height it will outperform 3 or 4 element beams at a lesser height. If you prefer, you can call your local TV shop and they'll put the whole thing up for you at an approximate charge of \$30 to \$40.

Of course we also manufacture 3 and 4 element beam antennas. If you can mount these on a 60 to 70 foot tower with a more costly heavy duty rotator, then by all means this is the ideal arrangement.

But if your choice is between putting a 3 or 4 element beam on a 30 or 40 foot tower, or the 2 element model at 60 to 70 foot, from a standpoint of dollar value, we recommend the TB-2... it's a giant killer.

It may sound odd for us to be talking you out of buying our more expensive models, but Swan has always been known for giving the radio ham more value for his dollar. In this case, the TB-2 on an inexpensive telescopic TV mast and rotator is a remarkable value.



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Swan's TB-4H .....	\$119
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Total .....	\$114

Swan also manufactures 67 other pieces of amateur equipment. Write for the complete 1971 Swan catalog.

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## hep functional circuits

The new series of Motorola HEP audio functional integrated circuits is designed to provide a complete audio system for experimenter projects. The HEP functional circuits are available in three power output levels: HEP type C6004 provides 1 watt of audio and is priced at \$2.60; type C6005 provides a minimum of 2 watts and is priced at \$4.35; the 4-watt HEP C6006 sells for \$5.60. All these units are high-gain devices, include a preamplifier, and will provide full-rated output with an input signal in the 10-to 15-mB range. The circuit can be used with 4-, 8- or 16-ohm speakers. A mail-order source for Motorola HEP devices is Circuit Specialists Company, Box 3047, Scottsdale, Arizona 85257. For more information, use *check-off* on page 94.

## ampress speech processor



The C. E. Cox Company has introduced its new solid-state *Ampress* speech processor, a high-performance low-cost unit designed to increase talk power and improve speech quality. The *Ampress* is not a speech clipper, but a variable-gain preamplifier that uses controlled negative-feedback to produce a constant output level automatically. The circuit operates with very fast attack time to accommodate transients. In addition, the *Ampress* incorporates a "speech enhancement" feature which amplifies voice signals selectively, with frequency response controlled by the compression function. The result is a crisp penetrating signal with carefully exaggerated speech

harmonics and high-frequency components to punch through heavy QRM.

The *Ampress* will work with all amateur rigs, a-m, fm and ssb, and comes in two attractive models: the CCA-1 which operates on three pen-light cells, or the CCA-1R which operates on three rechargeable cells and has an internal current regulator and external ac adapter/charger. The price of the CCA-1 is \$29.95; the CCA-1R is \$39.95. For more information, write to the C. E. Cox Company, 2415 Broadway, Santa Ana, California 92707, or use *check-off* on page 94.

## understanding solid-state circuits

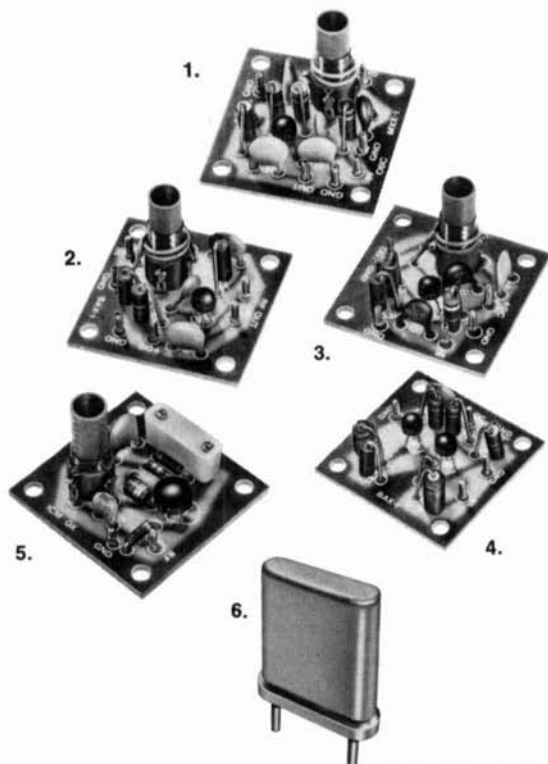
This new book by Norman Crowhurst presents all the information one might need to become acquainted with practical solid-state circuits. The author has cut away all the unnecessary verbiage on semiconductor theory and gotten right down to the circuits themselves. First there's a brief discussion of the various types of semiconductors and their operating modes; then comes a thorough but practical discussion of linear amplification. The author covers dc and ac feedback, current gain, controlling current and voltage gain, phase inversion and deals with typical everyday circuits.

The next chapter covers power amplification using single and push-pull stages, complementary symmetry and protection circuits. Then comes a thorough treatment of feedback and its applications, fet stabilization, high-frequency losses, equalization, rolloff and filter alignment. Sinusoidal oscillators and function generators are also covered in detail. Other subjects included in this helpful book are gain-controlled amplification, limiting and compression, expansion, attenuators, logic and integrated circuits. 192 pages. Over 150 illustrations. \$7.95 (\$4.95 paperbound) from Tab Books, Blue Ridge Summit, Pennsylvania 17214, or use *check-off* on page 94.

# for the experimenter!

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## two-meter transceiver



The new solid-state Comcraft CTR-144 two-meter transceiver combines all the most desirable features possible into a small portable unit. The double-conversion receiver has crystal-controlled first conversion for maximum stability; mosfets are used in the rf amplifier and mixer stages. Noise figure of the receiver is 4 dB. A three-pole Butterworth filter in the front end provides more than 80-dB image rejection, eliminating interference from the aircraft band. An automatic noise limiter and adjustable squelch are built in. I-f bandwidth is 18 kHz.

The transmitter frequency may be controlled by crystal or by the built-in vfo; the crystal oscillator uses standard 8-MHz crystals. The CTR-144 vfo operates at 7 to 9 MHz; vfo output is mixed with 65 MHz to produce 72 MHz output — this is doubled to 144 MHz. Receiver and transmitter vfo tuning are completely separate.

The only transmitter adjustments needed are output tuning and load; a front-panel switch provides selection of either a-m or fm. Power input is 12 watts; power output, 6 watts. The CTR-144 may be operated on its internal 117 Vac power supply, or any 12- to 18-volt dc source capable of 2 amps (the receiver requires only 100 mA). An optional clip-on rechargeable battery pack permits portable operation.

The baked-on epoxy finish of the Comcraft CTR-144 resists scratching and other marring. The panel is brushed

aluminum with lettering permanently anodized in. The circuit boards are military-style glass-epoxy types with solder-plated terminals. The CTR-144 is priced at \$389.95, including a crystal for 146.94 MHz. For more information, write to Comcraft Company, Post Office Box 266, Goleta, California 93017, or use *check-off* on page 94.

## foreign language QSOs

The use of foreign languages by American amateurs is increasing rapidly. The primary motivation is probably the pleasure afforded by exchanging greetings with a foreign operator in his native language. Europeans have always used amateur radio as an effective means for practicing English, and, now that ssb has made voice contacts so easy, language partners are available who wish to learn English and are willing to trade German, Spanish, French, etc., for practice in English. For the ham with language training or interest, *Foreign Language QSOs* add a new dimension and a satisfying proficiency to his hobby.

The *Foreign Language QSO* tapes have several advantages: genuine ham jargon is used throughout; the tapes are prepared by native hams who know the right phrases actually used.

The Armed Forces method of language teaching is imitated; you advance through dialogue and questions and answers, thereby increasing your vocabulary and grammatical ability. Also, sufficient material is provided to challenge the person who already has studied a foreign language and wants to sharpen his abilities, especially for amateur radio use. In addition, a complete English translation of all text, and basic information about the structure of the target language is provided.

*Foreign Language QSOs* are available in tapes or cassettes, English-Spanish or English-German. For more information, write to Foreign Language QSOs, Post Office Box 53, Acton, Massachusetts 01720, or use *check-off* on page 94.





## *get the picture!*

Shown above is an actual size, unretouched photo of the picture image taken from the Robot Model 70 Slow Scan Television monitor, as it was transmitted by the Robot Model 80 Slow Scan Television Camera.



ROBOT MODEL 70 MONITOR.....\$395  
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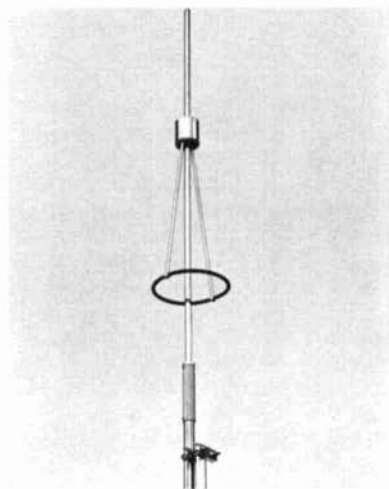
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## omnidirectional fm antenna



The Avanti ARD-257 is a completely new design in vertical omnidirectional 2-meter fm antennas for ham use. The patented tapered skirt configuration produces 4.17 dB gain (measured over a 1/4-wave ground plane) plus a low angle of radiation that has proven effective in eliminating dead spots. The ARD-257 uses no coils or transformers so it will not detune or burn out and is unaffected by temperature and humidity. Small projected area provides easy mounting and reduces wind load and icing problems. The antenna comes complete with coax lead, mounting hardware and fiberglass mast current eliminator. In addition, other frequencies are available from 140-175 MHz for marine, business use, etc.

The bandwidth of the ARD-257 is specified at  $\pm 3.5$  MHz; vswr is 1.5:1 or less. Nominal input impedance, 50 ohms; power handling capability, 1000 watts; length, 65 inches; weight, 3 pounds; wind survival, 120 miles per hour; price, \$44.95. For more information, use *check-off* on page 94 or write to Avanti Research & Development, Inc., 33-35 West Fullerton Avenue, Addison, Illinois 60101.

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**SIZE:** 10-1/2" x 13-1/2" x 4-1/2". Shpg wt 25 lbs.

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6.3-7 Mc.	BC-458	\$ 8.95	---	\$11.95
7-9.1 Mc.	BC-459	---	---	\$23.50

**TG-34A CODE KEYS**, self-contained, automatic, reproduces code practice signals from paper tape. 5 to 12 WPM Built-in speaker. Brand new with tech manual. takeup reel and AC line cord. ... **\$24.50**  
Code practice tapes for above P.U.R.



**BC-1206-C RECEIVER** Aircraft Beacon Receiver 200 to 400 Kc. Operates from 24V DC 1.5A. Continuous tuning, vol control, on-off switch and phone jack. Very sensitive. Compact. Complete with tubes, NEW..... **\$12.50**



**BC-604 FM TRANSMITTER** 20 to 27.9 Mc. Output approx 30 watts. 10 crystal controlled channels. Complete with tubes.  
NEW..... **\$12.50**



ARC-R11A Modern Q-5 Receiver 190 - 550 KHz ..... **\$10.95**  
ARC-R22 540 - 1600 KHz Receiver with tuning graph ..... **\$15.95**  
R-4/ARR-2 Receiver 234-258 Mhz, 11 tubes, NEW ..... **\$8.95**

EE-8 SIGNAL CORPS FIELD PHONES..... \$16.95  
T-30 THROAT MIKE, NEW..... 59¢ USED..... 39¢  
T-17 MICROPHONE, NEW..... \$8.50 USED, checked out \$4.95  
BC-605 INTERPHONE AMPLIFIER, NEW \$3.45 EXC. USED..... \$1.95  
TELEPHONE HANDSET, W.E. type..... LIKE NEW \$2.95  
SCR-522 TRANSMITTER-RECEIVER, with 18 tubes. LIKE NEW \$39.50

BC-624 RECEIVER 100-156 Mc, with tubes, exc. used.... \$23.50  
BC-625 TRANSMITTER 100-156 Mc with tubes, exc. used.. \$23.50  
RAY-3 NAVY RECEIVER high freq. AM, like new..... \$ 9.50  
TELEPHONE HANDSET, like new..... \$ 2.95  
FULL WAVE SELENIUM RECTIFIER 110V @ 150 Ma, New \$ .22

**AM-300/AIC PUSH/PULL AMPLIFIER**  
4-tube PP power amplifier with dynamotor, works on 28 VDC. Automatic gain control.  
Shpg wt 15 lbs. LIKE NEW..... **\$5.95**



FTR MINIATURE CHOKE, hermetically sealed, rated 2 henries at 130 Ma, Upright mounting, Special Buy, NEW..... \$ .29

AUTOMATIC BATTERY FILLER doubles battery life! Use one for 6V, two for 12V. Mounting bracket, instructions. NEW... \$ .69

**McELROY AUTOMATIC KEYS** for keying transmitter or for code practice. Photoelectric cell & sensitive relay. Variable speed motor 110V 60 cy Complete with tubes, EXC. USED ..... **\$11.25**



**BC-733 RECEIVER** Receives radio signals being transmitted by US satellite on approx. 108 Mc. AM, crystal-controlled on 6 preset freqs. in 108.3 to 110.3 Mc range. Operates on 12/24 V DC & 220 VDC 80 Ma. Complete with 10 tubes. Can be converted to FM Receiver  
80 to 108 Mc. Exc. Used..... **\$6.95**  
BC-732A Control Box for above, NEW... 1.75



**T-41 / APS - 18 TRANSMITTER ANTENNA UNIT** designed for 115 V 800 to 1400 cps. Tubes included are two 15E and one 15R. Complete with shock mounts and blower motor. 7x8x18", NEW.... **\$8.95**



**BC-223AX TRANSMITTER** 25 Watt, CW, MCW, Voice, Crystal control on 4 pre-selected channels, range 2000 to 5200 Kc by use of 3 plugin units, included. Complete.  
BRAND NEW..... **\$27.50**



**APN-1 FM TRANSCEIVER** 400-450 Mc. Freq. modulated by moving coil transducer. Easily converted for radio control or 70 cms. Complete with 14 tubes, dyn.  
BRAND NEW..... **\$9.95**



**AM-26/AIC PHASE INVERTER AMP.** 4-tube pushpull power amplifier. Carbon mike input, hi-imp. output. Works on 24VDC. Easily converted to dandy 9-watt amplifier. Complete with tubes and dynamotor  
LIKE NEW ..... **\$5.95**



**DUAL AMPLIFIER** has two input circuits each feeding a single 6SN7GT twin triode amplifier Complete with 115V 60 cy. power supply using 6X5GT rectifier. NEW..... **\$6.95**



**IP-69A/ALA-2 INDICATOR** 3" scope. Front panel controls: Vertical Pos., horizontal pos. intensity, focus, gain, width, center freq. Pan. Operates on 115 V 380 to 1000 cps. Complete with tubes. LIKE NEW..... **\$27.50**



**TG-5B TELEGRAPH SET** for code communications or code practice. Portable, with hinged lid. Two or more units operate up to 25 miles apart. Bell call system, 1000 cycle howler, key, headpiece, canvas case, book.  
Size 5-1/2x5-1/2x10". NEW..... **\$8.95**



**CARTER GENERATOR** Input: 5.9 VDC 32 Amps. Output: 405 VDC .270 Amps. Fine for mobile ham gear. Built-in hash filter. NEW **\$4.95**



**CARTER MAGMOTOR** Input: 6 VDC 3.6 Amps. Output: 250 VDC .030 Amp.  
#MA25035 NEW..... **\$2.65**



**DM-34 DYNAMOTOR** Input 14 VDC 2.8 Amps. Output: 220 VDC 80 Ma. Size 3" x 4-1/2" x 6-1/4". Wt. 5 lbs. NEW..... **\$4.45**



**TS-126/AP RANGE CALIBRATOR TEST SCOPE** Top quality 2" scope with all positioning, focus, gain and intensity controls. Complete with tubes and cables, NEW. **\$24.50**  
Demilitarized, like new..... \$13.75



**TELEPHONE TYPE RELAY**  
Made by J.H. Bunnell, has adjustable sensitivity. 150 ohm coil. NEW..... **\$3.45**



**WILLARD 2-VOLT STORAGE BATTERY**  
Rated at 20 Amp.-Hours. Model 20-2. Rechargeable. Compact nonspill construction. Lightweight polystyrene container, 3x4x5 1/2". Shipped dry, uses standard electrolyte. Shipping Weight 3 lbs. NEW, each..... **\$2.79**



TERMS: 25% Deposit with order, balance C.O.D. -or- Remittance in full. Minimum order \$5.00 F.O.B. NYC. Subject to prior sale and price change.  
**G&G RADIO ELECTRONICS COMPANY**  
45-47 Warren St. (2nd Fl.) New York, N.Y. 10007 Ph. 212-267-4605

# HAL DEVICES



**HAL 311BC  
ELECTRONIC  
KEYER  
\$53.00**

The most versatile keyer available. Send for full details on the HAL 311BC and the complete line of HAL electronic keyers. There is a model to fit your requirement and budget from \$16.50 to \$53.00. Shipping extra. Available in kit form for even greater value.



**HAL  
TOUCHCODER II  
KIT  
\$55.00**

**HAL TOUCHCODER II KIT \$55.00**

Complete parts kit, excluding keyboard, for the W4UX CW code typer. All circuitry on one 3 x 6" G10 glass PC board. Plug-in IC sockets. Optional contest ID and RTTY features available. New keyboard under development.

**HAL DIP BREADBOARD CARD**

Drilled G10 glass PC board accepts 6 16 pin DIP IC's in plug-in sockets. Each IC pin fanned out to two pads. Plugs into standard 22 pin edge connector (.156" finger spacing). \$5.50

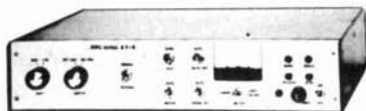
**DOUBLE BALANCED MODULATOR KIT**

For the DBM in March 1970 Ham Radio 7/8 x 2" drilled G10 glass PC board  
4 HP-2800 hot carrier diodes matched by HAL.  
2 Indiana General CF102-Q1 toroids.  
Wire and instructions included. \$6.50

**HAL 25KHZ GENERATOR**

Generates 50 KHz or 25KHz markers from 100 KHz oscillator (not supplied)  
Drilled 1 x 2" G10 glass PC board  
Strong markers to 148 MHz. Divides any signal up to 2MHz by 2 or 4. \$4.25 kit form.

Hot Carrier Diodes	HP2800	90¢	12/\$10.00	Matched by HAL	4/\$4.25
Linear IC's	SN72709N	\$1.00		SN72709L	\$1.25
	SN72710N	\$1.25		MC1429G	\$3.75
	MC1496G	\$3.25		MC1595G	\$5.60
Digital IC's	J4L 914	60¢		J4L 923	90¢
MRTL	MC890P	\$2.00		MC890P	\$3.50
	MC724P, MC725P, MC789P, MC792P	\$1.05			\$1.05
	MC790P	\$5.45		MC771P	\$1.75
				MC970AP	\$3.30
TTL	7400P, 7401P, 7402P, 7410P, 7420P, 7430P	75¢		7441AP	\$3.90
	7442P, 7495N	\$4.00		7472P	\$1.20
	7475P	\$2.75		7490P	\$2.50
FETS	40673 MOSFET	\$1.60		MPF102 JFET	60¢
TOROIDS	Indiana General CF102 Q6, CF102 Q1, CF101 Q2	\$1.25		FERROXUBE FERRITE BEADS	10/\$1.25
	CF102 Q3	\$1.25			
CINCH IC SOCKETS				8-IC, 14-DIP	80¢
				16-DIP	75¢



**HAL MAINLINE ST-6 RTTY TU**

Complete parts kit for the W6FFC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. \$135.00 kit. Wired units available.

Shipping extra. Write for full details.



**HAL RT-1  
TU/AFSK  
KIT  
\$51.50**

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch. High and low impedance audio output. Price \$45.00. Shipping extra. Write for full details. HAL Designer Cabinet for the above \$6.50. 3 pole Butterworth filter drilled PC board \$3.00.

**HAL MAINLINE ST-5 RTTY TU**

ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. \$50.00. Less boards, meter & meter components \$37.50. Boards only \$6.00. Shipping extra.

**HAL MAINLINE AK-1 AFSK OSC**

HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. \$27.50. Board only \$4.00. Shipping extra.

**HAL ID-1 REPEATER IDENTIFIER**

TTI logic. Power line frequency counter for 3 minute or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details.....\$75.00 Wired.

**ORDERING INFORMATION**

Postage is not included in the prices of HAL products. Please add 75¢ on small parts orders, and \$2.00 on larger kits. Shipping is via UPS when possible, and via insured parcel post otherwise. Please give a street address. Catalog of all items 24¢ postage.

**HAL DEVICES, Box 365H Urbana, IL 61801**

# flea market



■ **RATES** Commercial Ads 25¢ per word; non-commercial ads 10¢ per word payable in advance. No cash discounts or agency commissions allowed.

■ **COPY** No special layout or arrangements available. Material should be typewritten or clearly printed and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** can not check out each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue. Deadline is 15th of second preceding month.

■ **SEND MATERIAL TO:** Flea Market, Ham Radio, Greenville, N. H. 03048.

**TOROIDS! LOWEST PRICE ANYWHERE.** 40/\$10.00 POSTPAID (5/\$2.00). Center tapped, 44 or 88mhz. 32KSR page printer, reconditioned, perfect \$225. MITE UGC41KSR page printer, reconditioned, \$250. Model 28 sprocket to friction kit, \$25. Model 15KSR, \$65. Matching RA87 P.S. unused, \$5. Sync motors, \$7. 14TD 60 speed, \$25. 14DPE tape punch, \$15. HP 200CD audio oscillator, \$75. 11/16" reperferator tape, 40/\$10.00. Model 33ASR complete, \$650. Stamp for listing. Van W2DLT, 302H Passaic, Stirling, N. J. 07980.

**WARREN ARA 14th HAMFEST** - Still the friendliest. Sunday, August 22, new site: Yankee Lake, on Ohio Rt. 7, five miles north I-80. Picnic, swimming, playground. Prizes, giant free flea market, displays. For details & map, send card: Hamfest, Box 809, Warren, Ohio 44480.

**FOR SALE: DRAKE 2B, 2BQ, 2AC, \$150.00.** Motorola 2m fm 140D 60 watt transceiver with HB base power supply, \$90.00. Wanted: Gonset 3063 2 meter amp. L. Martin, WA1HDW, 10 Buzzards Bay Avenue, Woods Hole, Mass. 02543.

**OSCILLOSCOPE, 3", Military OS-34/USM-32.** Compact modern styling. 4 MHz Vertical Bandwidth, 10-200.00 usec Sweep Time, Time Marker Generator and Voltage Calibrator are some of its features, \$95.00. Other scopes from \$45.00 to \$500.00. James R. Walter, 2697 Nickel, San Pablo, California 94806.

**TOROIDS 44 and 88 mhz.** Unpotted, 5 for \$1.50 ppd. W. Weinschenker, Box 353, Irwin, Pa. 15642.

**QSL'S — BROWNIE W3CJI** — 3111B Lehigh, Allentown, Pa. 18103. Samples 10¢. Cut catalogue 25¢.

**DRAKE R-4B, 2-NT, MS-4, 17 novice crystals.** About 100 hours novice use \$485.00. F. Ross, 1500 Gondar Avenue, Long Beach, CA 90815.

**UNUSUAL RECEIVER VALUES:** Collins 75SI \$295; Collins 75S3 \$395; Hammarlund HQ170 \$159; Hammarlund HQ170A/VHF \$199; Hammarlund HQ-180AC \$299; National NC300 \$119; Many more. Get Complete Listing. Stan Burghardt, W0IT, Box 73H, Watertown, S. D. 57201.

**AUDIO FILTERS:** Knock down that background noise. KOJO SSB, AM, and CW filters do the job. Write for free brochure and see how serious DX boys hear them. KOJO, Box 7774, 741 E. Highland Ave., Phoenix, Arizona 85011.

**HAMFEST:** Indiana Radio Club Council's annual picnic Sunday, July 11th, LaPorte County Fairgrounds, LaPorte, Indiana. Large Flea Market with reserved locations available for large exhibitors and vendors on the Midway and Main Building. Mobile FM Clinic. Prizes. Tech Sessions. For flyer, write: Dave Osborn, K9BPV, P. O. Box 272, LaPorte, Indiana 46350.

**SURPLUS CRYSTALS BLANKS:** Range 4100-6800 kHz. 7200-8600 kHz. Assorted freq. our selection. 30/\$1. Nat Stinnette Electronics, Umattilla, FL 32784.

**MECHANICAL FILTERS:** 455 Khz. 2.1 Khz \$18.95. 300 Hz \$22.95. J. A. Fredricks, 314 South 13th Ave., Yakima, Washington 98902.

**THE CALGARY AMATEUR RADIO** Association announces that it will operate station VE6NQ from the grounds of the Calgary Stampede from July 8-17, 1971 inclusive. The schedule calls for operation from 1900 to 0500 GMT daily. Prevailing band conditions will dictate which frequencies shall be used at any time. Operating frequencies will be near or at 3.560, 3.780, 3.825, 3.900, 3.943, 7.060, 7.190, 7.225, 7.270, 14.060, 14.150, 14.250, 14.336, 21.060, 21.240, 21.300, 28.060, 28.500, 28.600 MHz. Several transmitters will operate simultaneously. Net call-ins will be accommodated. A special QSL card will be sent to all contacts. A QSO with VE6NQ during this period will count as two Calgary contacts for those amateurs working for their Calgary Stampede Certificate. Calgary Amateur Radio Association, Box 592, Calgary 2, Alberta.

**OLD TIME RADIO SHOWS.** SASE. Box 724, Redmond, Washington 98052.

**CINCY STAG HAMFEST:** The 34th Annual STAG Hamfest will be held on September 26, 1971 at Stricker's Grove, Cincinnati, Ohio. Door prizes each hour, raffle, lots of food, flea market, model aircraft flying, and contests. Identify Mr. Hamfest and win prize. \$5.00 cost covers everything. For further details contact, John Bruning, W8DSR, 6307 Fairhurst Avenue, Cincinnati, Ohio 45213.

**BELIEVE IT OR NOT** — The International Amateur Radio Society has clubs for every professional avocation. You name it. Send s.a.s.e. for information. IARS, P. O. Box 385, Bonita, California 92002.

**VHF NOISE BLANKER** — See Westcom ad in Nov., Dec. '70 and Mar. '71 Ham Radio.

**THE ZERO BEATER AMATEUR RADIO CLUB** will hold their annual Hamfest at the Washington, Mo. City Park on August 1st, starting at 10 a.m. Free Ham Gear Auction. Many fine Ham gear door prizes and free entertainment for the children and YI's.

**CLEGG THOR VI** Mobile rig, complete with 416 DC supply and modulator. Will include mobile mount, Squalo and coax, mike, speaker, xtals, and spare new driver and final. \$100.00 FOB. R. W. Solomon, 19 Pierce Road, Watertown, Massachusetts 02172.

**REALISTIC TRANSMITTER BARGAINS:** Johnson Valiants \$89; Johnson Factory Wired Valiant with Johnson SSB Adapter \$189; Many more. Get Complete Listing. Stan Burghardt, W0IT, Box 73H, Watertown, S. D. 57201.

**WORLD QSL BUREAU** — see ad page 91.

**OUTSTANDING SSB DEALS:** Drake T4XB/R4B/AC4/MS4 \$795; Galaxy III and DC Supply \$189; Heath HW32A \$79; National NCX3/NCXA \$219; National NCX5-MKII/NCXA \$399; Many More. Get Complete Listing. Stan Burghardt, W0IT, Box 73H, Watertown, S. D. 57201.

**THE CHRISTIAN AMATEUR RADIO FELLOWSHIP** will have a station (K9IGB/5) on the air at the North American Christian Convention at Dallas, TX July 6-9, 1971. Fred Basye is conducting a workshop July 8 at the convention entitled "Ham Radio — Keeping Touch Around The World."

DYNAMIC COMMUNICATIONS, INC.  
301 BROADWAY RIVIERA BEACH, FL. 33404 305 844-1323

Dear OM:

Be sure to stop at our display at EXPO 71 and see the following  
Dycomm products unveiled:

220 MHz Repeaters and Transverters

Compact RF Sniffers

Model 1010 Transceivers

100 Watt Power Boosters

Even more exciting is the fact that we will have a whole truckload  
of these exciting goodies in stock and ready for immediate sale.

Then, there is our complete line of power boosters including the  
new Super Brick Booster. If you have a hot HT it will give you up  
to 50 watts and typically 40 watts output for 2 watts input. We call  
this a Dycomm 500 ES and price it at only \$99.95. It will take your  
Drake MLR-2 and give you at least 30 to 40 watts output.

What's the scoop on this 220 transverter? With a flip of a switch  
your existing 10 watt 2 meter transceiver becomes a 20 to 30 watt,  
220 transceiver with simplex and duplex operation for any of the  
220 MHz channels. See it demonstrated at EXPO 71 with companion  
repeaters inexpensively priced, all solid state.

See you there!

73,



Jim Penney, W4MRI

**FOR SALE — COLLINS 75A3** in excellent condition \$200.00. Collins 30L1 amplifier in excellent condition \$300.00. K4ARS, G. E. Goss, 2209 Wakefield St., Alexandria, Va. 22308. You pay the freight.

**HAMMARLUND SP-600-JX-26** General Coverage (.54-54mhz) Receiver. Excellent Condition. \$175.00. William Lee, Rt. 2, Paxton, Illinois 60957.

**DON'T BUY QSL CARDS** from anyone until you see my free samples. Fast service. Economical prices. Little Print Shop, Box 9848, Austin, Texas 78757.

**EXCLUSIVELY HAM TELETYPE** — 19th year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 30¢. \$3.00 year. Box 837, Royal Oak, Michigan 48068.

**QSLs. SECOND TO NONE.** Same day service. Samples 25¢. Ray, K7HLR, Box 331, Clearfield, Utah 84015.

**HEATH TEST EQUIPMENT:** Scanalyzer SB-620 \$90.00, Transistor Analyzer IM-36 \$45.00, 5mc Oscilloscope IO-17 \$55.00, Scope Probe PK-1 \$3.50, Demodulator Probe 337-C \$3.50, Tunnel Dipper HM-10A \$20.00, FET VOM IM-25 \$60.00, 30kv Probe 336 \$4.50, RF Probe PK-3 \$4.00. All mint. Complete lot \$250.00. K7CPW, 2115 Wolfe Place West, Seattle, Washington 98193.

**HOOSIER ELECTRONICS** Authorized dealers for Drake, Hy-Gain, Galaxy, Regency. All equipment new and fully guaranteed. Write today for our low quote. Hoosier Electronics, Dept. G, R. R. 25, Box 403, Terre Haute, Indiana 47802.

**CONNECTICUT HAMS:** Come and see all the goodies at Roger S. Miner Surplus Electronics, 246 Naugatuck Ave., Milford, Conn. 06460. Telephone 877-0555.

**WANTED** R390, R390A, R389, 51J4, 51S1, Racal, Nems, Clarke, Marconi receivers. SWRC, P. O. Box 10048, Kansas City, Missouri 64111.

**FM MONITOR RECEIVERS** Vanguard Model 150. Demonstrators with 146.94 crystal only \$39.95. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N. Y. 11423.

**ORIGINAL EZ-IN DOUBLE HOLDERS** display 20 cards in plastic, 3 for \$1.00, 10 for \$3.00 prepaid. Guaranteed. Patented. Free sample to dealers. Tepabco, John K4NMT, Box 198R, Gallatin, Tenn. 37066.

**ASK FOR FREE LIST** of used Ham gear or for prompt personal attention on any new gear. Mail your order direct to VanSickle Radio, W9KJF, Indianapolis, Indiana 46205. 40 years experience.

**THE FOOTHILLS RADIO CLUB, INC.** of Greensburg, Pennsylvania, will hold its fourth annual Hamfest, on July 11, 1971 a Wendel Ball Field, Wendel, Pa., 2.4 miles from the Irwin interchange of the Pa. turnpike. Over \$600.00 in prizes plus 50/50 drawing. There will be check-ins on 10 and 6 meters. Refreshments at moderate prices and new this year, BINGO for the Ladies. Just follow the signs if you want to have fun in '71.

**SURPLUS MILITARY RADIOS,** Electronics, Radar Parts, tons of material for the ham, free catalogue available. Sabre Industries, 1370 Sargent Ave., Winnipeg 21, Manitoba, Canada.

**TELETYPE #28 LRXB4** reperforator-transmitter "as is" \$100; checked out \$175. Includes two 3-speed gearshifts. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

**AMATEUR RADIO CLUBS ATTENTION:** Affiliate with the International Amateur Radio Society. Write IARS, P. O. Box 385, Bonita, Calif. 92002.

**FREQUENCY SCALER** divides-by-ten to 160 MHz. 20 mv sensitivity. Worth \$300. Limited quantity at \$99.50. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N. Y. 11423.

**VHF SELLOUT:** Ameco TX 62 \$89; Gonset GC105 \$69; Johnson 6N2 Transmitter \$69; Swan 250C/TV2B/117XC \$549; Swan TV2B New \$229. More items. Get Complete Listing. Stan Burghardt, WO1T, Box 73H, Watertown, S. D. 57201.

**"NIXIE" TYPE READOUTS** (w/internal point) \$2.90: 7441A drivers \$2.50; 7490 counters \$1.75; good selection 7400 series gates 35¢. DIP/IC sockets 17¢. Everything brand new. SASE full info. WA1HSJ, Box 1, Corinth, Vermont 05039.

## NEW — for 2M FM Tone Burst Encoder for Reliable Repeater Access

- One, two or six frequency models
- Fully automatic operation
- Screwdriver adjustable from 1500-2600 Hz
- 12 VDC powered — no batteries
- MIL Spec design, construction and performance

Priced from \$26.95  
send QSL for spec sheet

## NEW — for RTTY Phase Locked Loop Terminal Unit

- Copies shifts from 100 to 1000 Hz automatically
- Auto-track for drifting signals
- Enters "mark-hold" when signal fades
- Input tone range switchable to operate with SSB transceiver audio
- Autostart and selective call available

Write today for detailed specifications

See us at Radio Expo '71

**WCI**

PO Box 17, Schaumburg, Ill. 60172

## New 3 Digit Counter



• The model fm-36 3-digit frequency meter has the same features that has made the 2 digit model so popular with Hams — low price, small size (smaller than a QSL card), 35 Mhz top frequency, simple connection to your transmitter, +0 —0.1 KHz readout — PLUS the added convenience of a third digit to provide a 6 digit capability. Kit or Assembled.

Example: 28,649,800 Hz reads 28.6 MHz or 49.8 KHz. (Add the 10 Hz module to read 9.80.)

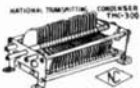
• A divide-by-ten prescaler is also available that operates up to 170 Mhz. Extend the range of any frequency counter — or use with the fm-36 for 6 meter or 2 meter use.

FM-36 KIT \$134.50  
FM-36 ASSEMBLED \$164.50

**Micro-Z Co.**

Box 2426 Rolling Hills, Calif. 90274

# B A R R Y



**NATIONAL TMC-300**, 300 pf, transmitting capacitor. .07" spacing. .....\$6.95

**6.3 VAC @ 2A** fil. xfmr. (115 VAC) .....\$1.95

**833/833A** tube socket. Johnson #212. ....\$12.95

**DYCOMM "Block Booster"** FM (2 mtr) amplifier, 50 watt output. 12 volt DC. ....\$89.95

**DYCOMM "Brick Booster"** 2 meter FM amplifier, 12 watt output. 1-3 watts input. 12 VDC. \$69.95



**30 AMP** filament choke. \$8.90

**SILICON BRIDGE RECTIFIER.** Tested at 6000 volts and 1 Amp. (4 separate rectifiers mounted on Nylon card.) 2 oz. Sale \$5.95

**JENNINGS UCS-300 VACUUM VARIABLE CAPACITOR.** Capacity range: tunes from a min. of 10 pf. to a max. of 300 pf. at 10 kV. Units are unused, "mint" condition, Lab-tested and certified O.K. in Aug. 1970. Without turning head at .....\$50.00

With turning head at .....\$66.75



**CRYSTAL OVEN:** Maintains 2 type HC6/U crystals at 65° C. Requires 6.3 volts for heater. Octal base. \$3.50

**DRAKE ML-2F FM MOBILE/BASE** .....\$329.95

**DRAKE TR-22 FM PORTABLE/BASE** .....\$199.95

**4" sq. PM Speaker**, 4Ω, 2 watts, new 90¢.

**10 for \$8.00/100 for \$60.00/1000 for \$500.00**



**Deluxe TRANSCO SP4T COAXIAL SWITCH** carries 2KW PEP @ 30MHz. Good to 3000 MHz. New, Sealed. ....\$17.50  
Orig. cost approx. \$300. each.



**VS-2 VACUUM RELAY** by Eimac/Bendix. Easily switches 2KW up to 15kV. Coil: 24 VDC. \$9.95

**WATERS MODEL 346** Nuverter. 2 & 6 M VHF converter. New. Orig. \$175.00 net. Sale \$80.00  
**RCA 1000.000 Khz CRYSTAL.** .....Only \$3.50

We have just bought out the complete inventory of a Florida distributor. Lots of new and used goodies. Collins, Drake, Hallicrafters, Cushcraft, Hy-Gain, Johnson, Millen, Mosley and much, much more. Come on in and look it all over.

Overseas visitors. Barry extends his welcome to you. We will help you with your purchases and try to make your stay in New York more enjoyable. Enjoy a separate, efficient, export dept. and test lab.

**CASH PAID . . . FAST!** For your unused TUBES, Semiconductors, RECEIVERS, VAC. VARIABLES, Test Equipment, ETC. Write or call Now! Barry, W2LNI. We Buy!


We ship all over the World. DX Hams only. See Barry for the new Alpha 70. (See front inside cover of this magazine.)

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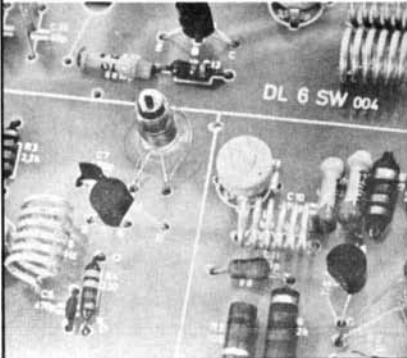
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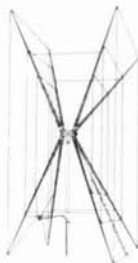
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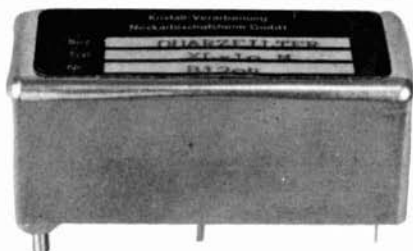
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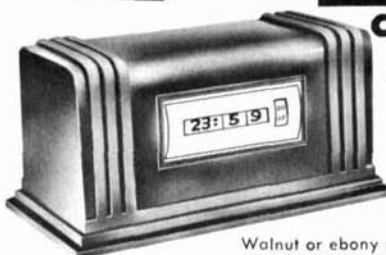
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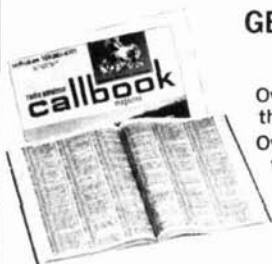
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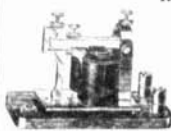
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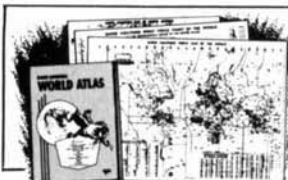
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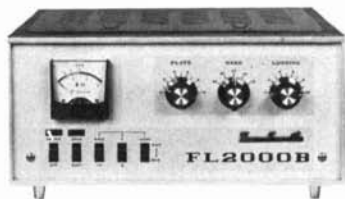
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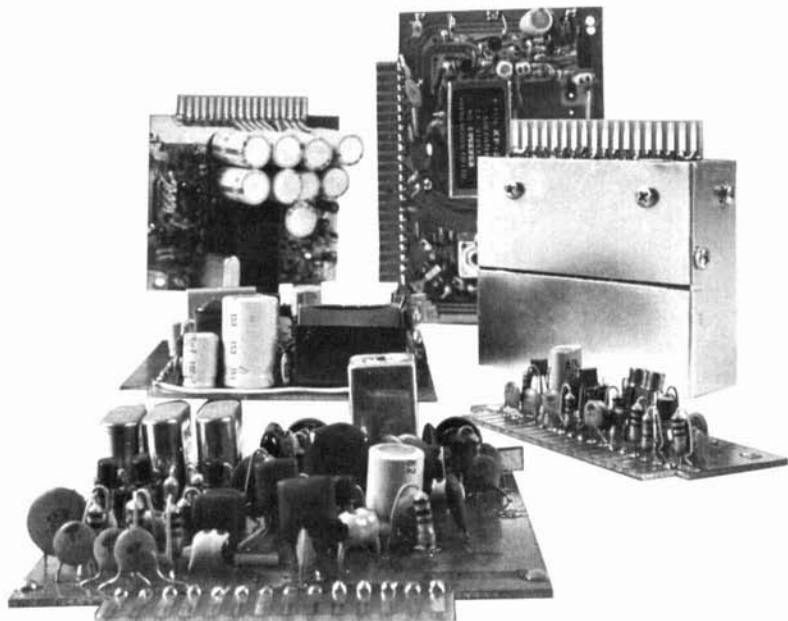
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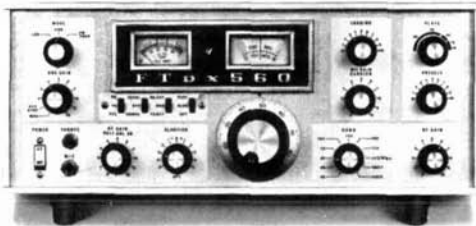
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